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STAR
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Scientific and Technical Aerospace Reports

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

***Scientific and Technical Aerospace Reports* (*STAR*)** is an abstract journal that provides comprehensive coverage of worldwide aerospace-related reports. It is a major product of the International Aerospace Database managed by the NASA Scientific and Technical Information (STI) Program. The coverage includes reports on aeronautics, space, and supporting disciplines. *STAR* lists current, publicly available reports entered into the NASA STI Database during the 2-week period preceding publication. An explanation of items that appear in each citation is given on the last page of each volume.

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Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation. For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

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Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust. For related information see also *75 Plasma Physics.*

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Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

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Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

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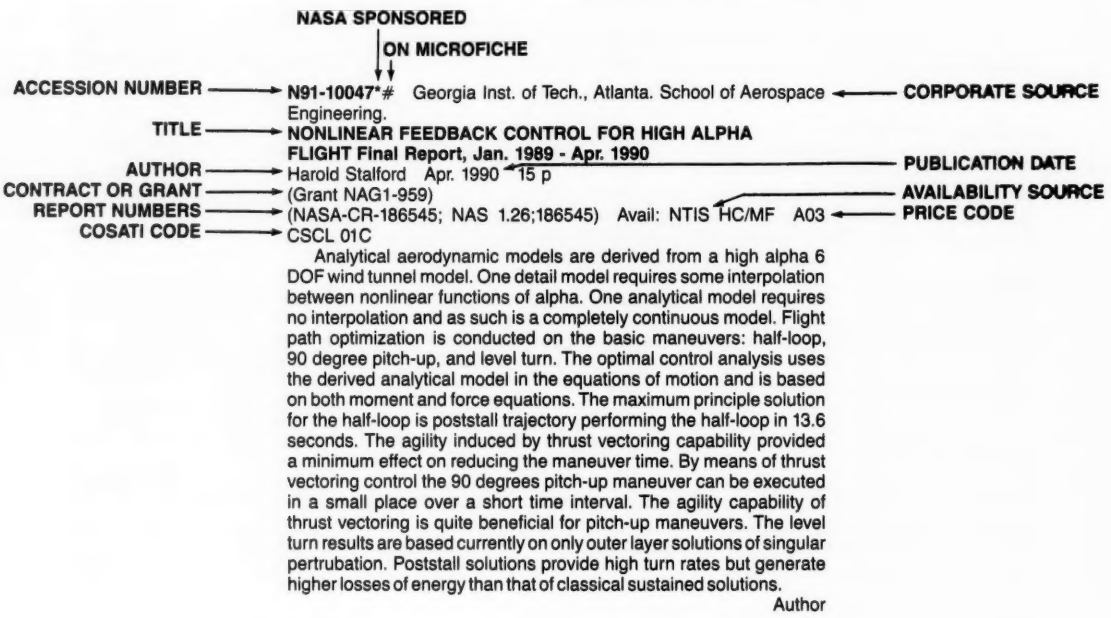
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ACCESSION NUMBER
N91-10047*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
CORPORATE SOURCE
TITLE
NONLINEAR FEEDBACK CONTROL FOR HIGH ALPHA FLIGHT Final Report, Jan. 1989 - Apr. 1990
PUBLICATION DATE
AUTHOR
Harold Stalford Apr. 1990 15 p
CONTRACT OR GRANT
(Grant NAG1-959)
AVAILABILITY SOURCE
REPORT NUMBERS
(NASA-CR-186545; NAS 1.26;186545) Avail: NTIS HC/MF A03
PRICE CODE
COSATI CODE
CSCL 01C
Analytical aerodynamic models are derived from a high alpha 6 DOF wind tunnel model. One detail model requires some interpolation between nonlinear functions of alpha. One analytical model requires no interpolation and as such is a completely continuous model. Flight path optimization is conducted on the basic maneuvers: half-loop, 90 degree pitch-up, and level turn. The optimal control analysis uses the derived analytical model in the equations of motion and is based on both moment and force equations. The maximum principle solution for the half-loop is poststall trajectory performing the half-loop in 13.6 seconds. The agility induced by thrust vectoring capability provided a minimum effect on reducing the maneuver time. By means of thrust vectoring control the 90 degrees pitch-up maneuver can be executed in a small place over a short time interval. The agility capability of thrust vectoring is quite beneficial for pitch-up maneuvers. The level turn results are based currently on only outer layer solutions of singular pertrubation. Poststall solutions provide high turn rates but generate higher losses of energy than that of classical sustained solutions.
Author

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Scientific and Technical Aerospace Reports

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01 AERONAUTICS (GENERAL)

N91-24087# Wichita State Univ., KS. National Inst. for Aviation Research.
KANSAS AVIATION REVIEW
Floyd Price, ed. 1991 45 p The 5th Annual Kansas State Aviation Conference was held in Liberal, KS, 14-16 Sep. 1990
(NIAR-91-3) Avail: NTIS HC/MF A03

The purpose of the Review is to provide a multi-disciplinary aviation publication opportunity. Topics addressed include: automated inspection of aging aircraft; secondary certification in aerospace education; cognitive performance in cockpits; information resources in aviation; demand for college aviation programs. For individual titles, see N91-24088 through N91-24092.

N91-24088# Wichita State Univ., KS.
EVALUATION OF AUTOMATION FOR INSPECTION OF AGING AIRCRAFT
Behnam Bahr *In its* Kansas Aviation Review 1991 p 1-8 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

A new automated/robotics system or a potential system for aircraft inspection is described. In order to develop a semi-automated or robotics system for the inspection of an aircraft, several facts need to be considered. Therefore, a set of criteria are prepared that will enable any interested party to make an appropriate response as to what type of system should be supported or bought. These issues may involve not only the selection of what mechanism is the best system but also if additional training will be required to implement the automated inspection. Author

N91-24089# Wichita State Univ., KS. National Inst. for Aviation Research.
ADDITIONAL SECONDARY CERTIFICATION IN AEROSPACE EDUCATION FOR KANSAS EDUCATORS **c80**
Brent D. Bowen and Robert Kuhns *In its* Kansas Aviation Review 1991 p 9-13 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

Additional secondary certification in aerospace education has been available at Wichita State University for a number of years. The past ten years have seen little, if any, interest in the program. This is probably due to the decline experienced in the local Wichita general aviation industry. Renewed interest in the program has now surfaced with three graduate students pursuing certification. This renewed interest led to the discovery of time-dated discrepancies in the curriculum. Some of the courses listed in the current curriculum are no longer offered, course names were changed, and new aviation courses developed. Students who would like to receive certification may individualize the curriculum given the broad guidelines of the current process. This program will facilitate complementary relationships between the College of Education, W. Frank Barton School of Business, and the National Institute of Aviation Research at Wichita State University. Wachita State University is currently the only Kansas institution from which certification may be obtained. However, several institutions offer courses, including aerospace educational workshops, which can be applied toward certification. A step-by-step process for obtaining additional secondary certification in aerospace education is explained. Author

N91-24090# Wichita State Univ., KS. Dept. of Industrial Engineering.
COGNITIVE PERFORMANCE CAPABILITIES IN THE COCKPIT **c54**
Randall M. Chambers and Mihriban Whitmore *In its* Kansas Aviation Review 1991 p 14-20 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

Using the cockpit of the Learjet 15 Flight Simulator, nine computerized cognitive performance tests were administered to thirty volunteer subjects who monitored selected flight instruments during laboratory controlled conditions. The primary objective of this research was to measure and assess cognitive performance abilities of subjects as they monitored cockpit instruments while exposed to variations in work load, engine noise, and instrument conditions. Cognitive performance profiles were obtained for subjective judgements and physiological response. Cognitive performance profiles were reported for the following tests: logical relations; following directions; missing items; tower puzzle; word anagrams; mark numbers; information purchase; numbers and words; and route planning. Analysis of variance was conducted to assess the effects of cockpit conditions upon cognition test scores and performance profiles. Author

N91-24091# Wichita State Univ., KS. Ablah Library.
AN OVERVIEW OF INFORMATION RESOURCES IN AVIATION **c82**
Thomas G. DePetro *In its* Kansas Aviation Review 1991 p 21-29 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

Information resources in aviation are produced by many sources, including publishing companies, government agencies, professional associations, research organizations, and colleges and universities. Aspects of aviation covered include: management, government regulations, air transport, engineering, technology, research and development, and applied sciences. Information is available in a number of formats including books, periodicals (magazines, journals, newspapers, newsletters), maps and charts, government documents, technical reports, professional papers, microfiche, and more recently, audio and video cassette tapes and CD/ROM and online computer databases. This overview serves an an introduction to what information is available from key organizations and how it is distributed and organized. Author

N91-24092# Wichita State Univ., KS. National Inst. for Aviation Research.
DEMAND ESTIMATION FOR COLLEGIATE AVIATION ACADEMIC PROGRAMS **c80**
Phillips W. Goodell *In its* Kansas Aviation Review 1991 p 30-38 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

Forecasting student enrollment in a new academic program at a university is similar to forecasting the demand for a new product or service in a business environment. The prime question asked by academic administrators and private sector business managers

alike is the number of customers willing to buy the offering. The issue of how one might go about providing a reasonable answer to such a question is addressed. A combination of approaches is suggested, including the following: (1) potential enroll concept interest study; (2) analogy to similar program introductions; (3) underlying student enrollment trend analysis, and (4) survey of expert opinion. While such methods may provide the new courses, proponents with a theoretically neat package of estimates and probability ranges, that the actual course sign-up is mainly the results of marketing follow-up. Author

N91-24093# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
SOME ANALYSIS OF DECISION-MAKING IN THE TEST MANUFACTURE OF MILITARY AIRCRAFT
Ruosong Wang 29 Nov. 1990 14 p Transl. into ENGLISH from Guoji Hangkong (Peoples Rep. of China), no. 319, Sep. 1989 p 23-24
(AD-A233111; FTD-ID(RS)T-0716-90) Avail: NTIS HC/MF A03 CSCL 01/2

Modern military aircraft are complex engineering systems. They include target or object systems, operating systems, as well as related structural systems. They form a large, complicated engineering system made up from natural systems and social systems. As far as the goodness or badness, the success of failure of this type of engineering is concerned, it is not simply a matter of one industry; one cannot even stop with a consideration of the aviation industry of one nation; it extends even to the nation as a whole. All these things are important factors. This type of engineering requires long periods of time. The technology is complicated and new. It has enormous consequences. In addition to this, the whole world is paying careful attention to it. As a result of this, its influence involves economic effects, military effects, and political consequences. GRA

N91-24094# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Technology Div.
AEROSPACE ACTIVITIES IN MODERN CHINA (CHAPTERS 1-3, PART 4)
10 Dec. 1990 122 p Transl. into ENGLISH from Dang Dai Zhong Guo De Hang Tian Shi Ye (China), v. 1, no. 1, 1986 p 359-437
(AD-A233419; FTD-ID(RS)T-0599-90) Avail: NTIS HC/MF A06 CSCL 22/4

The main topics presented include the following: (1) construction process and major technical facilities of China's aerospace launch sites and ground surface tracking and control networks; (2) special materials and processes developed for aerospace engineering; and (3) the major large ground experimental facilities and equipment. GRA

N91-24095* National Aeronautics and Space Administration, Washington, DC.
AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 265)
May 1991 152 p
(NASA-SP-7037(265); NAS 1.21:7037(265)) Avail: NTIS HC A08; NTIS standing order as PB91-914100, $17.00 domestic, $34.00 foreign CSCL 01A

This bibliography lists 554 reports, articles, and other documents introduced into the NASA scientific and technical information system in Apr. 1991. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author

N91-24096* National Aeronautics and Space Administration, Washington, DC.
AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 263)
Mar. 1991 146 p
(NASA-SP-7037(263); NAS 1.21:7037(263)) Avail: NTIS HC A08; NTIS standing order as PB91-914100, $17.00 domestic, $34.00 foreign CSCL 01A

This bibliography lists 517 reports, articles, and other documents introduced into the NASA scientific and technical information system in Feb. 1991. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author

N91-24097* National Aeronautics and Space Administration, Washington, DC.
AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 264)
Apr. 1991 159 p
(NASA-SP-7037(264); NAS 1.21:7037(264)) Avail: NTIS HC A08; NTIS standing order as PB91-914100, $17.00 domestic, $34.00 foreign CSCL 01A

This bibliography lists 558 reports, articles, and other documents introduced into the NASA scientific and technical information system in Mar. 1991. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author

N91-24160# Wichita State Univ., KS.
BONDED/FUSION REPAIR OF AIRCRAFT STRUCTURES
Wayne Becker and James Ho *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

N91-24163# Wichita State Univ., KS.
MECHANICAL PAINT REMOVAL TECHNIQUES FOR COMPOSITE AIRCRAFT
Jorge E. Talia, Behnam Bahr, Wayne Becker, and Hamid M. Lankarani *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

N91-24098*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE NASA LANGLEY LAMINAR-FLOW-CONTROL EXPERIMENT ON A SWEPT, SUPERCRITICAL AIRFOIL: SUCTION COEFFICIENT ANALYSIS
Cuyler W. Brooks, Jr., Charles D. Harris, and William D. Harvey Jun. 1991 19 p
(NASA-TM-4267; L-16774; NAS 1.15:4267) Avail: NTIS HC/MF A03 CSCL 01A

A swept supercritical wing incorporating laminar flow control at transonic flow conditions was designed and tested. The definition of an experimental suction coefficient and a derivation of the compressible and incompressible formulas for the computation of the coefficient from measurable quantities is presented. The suction flow coefficient in the highest velocity nozzles is shown to be overpredicted by as much as 12 percent through the use of an incompressible formula. However, the overprediction on the computed value of suction drag when some of the suction nozzles were operating in the compressible flow regime is evaluated and found to be at most 6 percent at design conditions. Author

N91-24099*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
AN INITIAL INVESTIGATION INTO METHODS OF COMPUTING TRANSONIC AERODYNAMIC SENSITIVITY COEFFICIENTS
Semiannual Progress Report, Jul. - Dec. 1990
Leland A. Carlson Feb. 1991 108 p
(Grant NAG1-793)
(NASA-CR-188192; NAS 1.26:188192; TAMRF-5802-91-01)
Avail: NTIS HC/MF A06 CSCL 01A

The three dimensional quasi-analytical sensitivity analysis and the ancillary driver programs are developed needed to carry out the studies and perform comparisons. The code is essentially contained in one unified package which includes the following: (1) a three dimensional transonic wing analysis program (ZEBRA); (2) a quasi-analytical portion which determines the matrix elements in the quasi-analytical equations; (3) a method for computing the sensitivity coefficients from the resulting quasi-analytical equations; (4) a package to determine for comparison purposes sensitivity coefficients via the finite difference approach; and (5) a graphics package. Author

N91-24100*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
NONEQUILIBRIUM RADIATION AND CHEMISTRY MODELS FOR AEROCAPTURE VEHICLE FLOWFIELDS, VOLUME 1
Semiannual Progress Report, Jul. - Dec. 1990
Leland A. Carlson Feb. 1991 165 p
(Grant NAG1-1003)
(NASA-CR-188196; NAS 1.26:188196; TAMRF-6382-91-01-Vol-1)
Avail: NTIS HC/MF A08 CSCL 01A

The following subject areas are covered: the development of detailed nonequilibrium radiation models for molecules along with appropriate models for atoms; the inclusion of nongray radiation gasdynamic coupling in the VSL (Viscous Shock Layer) code; the development and evaluation of various electron-electronic energy models; and an examination of the effects of shock slip. Author

N91-24101*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
NONEQUILIBRIUM RADIATION AND CHEMISTRY MODELS FOR AEROCAPTURE VEHICLE FLOWFIELDS, VOLUME 2
Semiannual Progress Report, Jul. - Dec. 1990
Leland A. Carlson Feb. 1991 141 p
(Grant NAG1-1003)
(NASA-CR-188198; NAS 1.26:188198; TAMRF-6382-91-01-Vol-2)
Avail: NTIS HC/MF A07 CSCL 01A

A technique was developed for predicting the character and magnitude of the shock wave precursor ahead of an entry vehicle and the effect of this precursor on the vehicle flow field was ascertained. A computational method and program were developed to properly model this precursor. Expressions were developed for the mass production rates of each species due to photodissociation and photoionization reactions. Also, consideration was given to the absorption and emission of radiation and how it affects the energy in each of the energy modes of both the atomic and diatomic species. A series of parametric studies were conducted covering a range of entry conditions in order to predict the effects of the precursor on the shock layer and the radiative heat transfer to the body. Author

N91-24102*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
NONEQUILIBRIUM RADIATION AND CHEMISTRY MODELS FOR AEROCAPTURE VEHICLE FLOWFIELDS, VOLUME 3
Semiannual Progress Report, Jul. - Dec. 1990
Leland A. Carlson Feb. 1991 33 p
(Grant NAG1-1003)
(NASA-CR-188195; NAS 1.26:188195; TAMRF-6382-91-01-Vol-3)
Avail: NTIS HC/MF A03 CSCL 01A

The computer programs developed to calculate the shock wave precursor and the method of using them are described. This method calculated the precursor flow field in a nitrogen gas including the effects of emission and absorption of radiation on the energy and composition of gas. The radiative transfer is calculated including the effects of absorption and emission through the line as well as the continuum process in the shock layer and through the continuum processes only in the precursor. The effects of local thermodynamic nonequilibrium in the shock layer and precursor regions are also included in the radiative transfer calculations. Three computer programs utilized by this computational scheme to calculate the precursor flow field solution for a given shock layer flow field are discussed. Author

N91-24103 Georgia Inst. of Tech., Atlanta.
AERODYNAMIC INTERACTIONS BETWEEN BODIES IN RELATIVE MOTION Ph.D. Thesis
Olivier Schreiber 1990 281 p
Avail: Univ. Microfilms Order No. DA9105464

The problem of aerodynamic interactions between bodies in arbitrary relative motion is considered, with emphasis on the aerodynamics of rotor with fuselage interactions. This problem is too complex to be analyzed using the full Navier-Stokes equations, and it has previously been shown that the dominant features of such flow field can be explained using ideal fluid flow concepts. Thus, an ideal fluid flow formulation, allowing complex unsteady interactions between arbitrary shaped bodies, is used. The computational scheme is time dependent and designed to handle several bodies moving with respect to each other, such as a rotor and fuselage. It is not specialized in its treatment of lifting versus nonlifting bodies or their motion characteristics. The wakes of the bodies are modeled by vortex particle. The handling of the Helmholtz equation, which governs vorticity convection and distortion and its interaction with the bodies, is simplified. Stability and convergence of the scheme are made by smearing the discrete point distribution over finite elementary volumes and using a multistep time marching integration method. A mix of boundary element methods is used simultaneously to solve the boundary value problem. Dissert. Abstr.

N91-24104 Georgia Inst. of Tech., Atlanta.
AN EFFICIENT HYBRID SCHEME FOR THE SOLUTION OF ROTATIONAL FLOW AROUND ADVANCED PROPELLERS Ph.D. Thesis
Rakesh Srivastava 1990 154 p
Avail: Univ. Microfilms Order No. DA9105466

A free air propeller offers the highest propulsive efficiency. However, as the flight speed increases, the high tip speed of a conventional propeller leads to large compressibility losses. To overcome these losses and extend the flight Mach number to near transonic range, propellers were redesigned to have large tip sweep, twist, and very thin airfoils. The efficiency was further increased by using a counter-rotating row of blades to recover the swirl losses. One problem with these advanced propellers, however, is that some of the propellers have fluttered in wind tunnel tests. In order to be able to predict flutter, an accurate prediction of unsteady airloads is necessary. Also, as the propellers operate in the transonic Mach number range, compressibility effects become important. In the present solution procedure, three-dimensional, unsteady, compressible Euler equations are solved. A directionally hybrid scheme is used to make the scheme computationally more efficient. The governing equations are cast in strong conservative form and solved in a body-fitted coordinate system using an approximate factorization scheme. Specifically, the solution procedure is applied to solve Euler equations around single and counter-rotating advanced propeller geometries to obtain airloads and integrated performance quantities. The solution procedure was also coupled with NASTRAN in an open loop fashion, to study the effects of blade flexibility on the performance of the single rotation advanced propeller. An attempt was also made to evaluate the possibility of reducing the number of grid points in the solution domain by using a fourth-order scheme. Author

N91-24105*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.

NONLINEAR AERODYNAMICS AND THE DESIGN OF WING TIPS Final Report, 1 Apr. 1990 - 31 Mar. 1991

Ilan Kroo May 1991 5 p

(Contract NCC2-683)

(NASA-CR-188044; NAS 1.26:188044) Avail: NTIS HC/MF A01 CSCL 01A

The analysis and design of wing tips for fixed wing and rotary wing aircraft still remains part art, part science. Although the design of airfoil sections and basic planform geometry is well developed, the tip regions require more detailed consideration. This is important because of the strong impact of wing tip flow on wing drag; although the tip region constitutes a small portion of the wing, its effect on the drag can be significant. The induced drag of a wing is, for a given lift and speed, inversely proportional to the square of the wing span. Concepts are proposed as a means of reducing drag. Modern computational methods provide a tool for studying these issues in greater detail. The purpose of the current research program is to improve the understanding of the fundamental issues involved in the design of wing tips and to develop the range of computational and experimental tools needed for further study of these ideas. For individual titles, see N91-24106 through N91-24106.

N91-24106*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE COMPUTATION OF INDUCED DRAG WITH NONPLANAR AND DEFORMED WAKES

Ilan Kroo (Stanford Univ., CA.) and Stephen Smith *In* Stanford Univ., Nonlinear Aerodynamics and the Design of Wing Tips May 1991 9 p (For primary document see N91-24105 16-02)

Avail: NTIS HC/MF A01 CSCL 01A

The classical calculation of inviscid drag, based on far field flow properties, is reexamined with particular attention to the nonlinear effects of wake roll-up. Based on a detailed look at nonlinear, inviscid flow theory, it is concluded that many of the classical, linear results are more general than might have been expected. Departures from the linear theory are identified and design implications are discussed. Results include the following: Wake deformation has little effect on the induced drag of a single element wing, but introduces first order corrections to the induced drag of a multi-element lifting system. Far field Trefftz-plane analysis may be used to estimate the induced drag of lifting systems, even when wake roll-up is considered, but numerical difficulties arise. The implications of several other approximations made in lifting line theory are evaluated by comparison with more refined analyses. Author

N91-24107*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EULER FLOW PREDICTIONS FOR AN OSCILLATING CASCADE USING A HIGH RESOLUTION WAVE-SPLIT SCHEME

Dennis L. Huff, Timothy W. Swafford, and T. S. R. Reddy (Toledo Univ., OH.) 1991 19 p Presented at the 36th International Gas Turbine and Aeroengine Congress and Exposition, Orlando, FL, 3-6 Jun. 1991; sponsored by ASME

(NASA-TM-104377; E-5933; NAS 1.15:104377) Avail: NTIS HC/MF A03 CSCL 01A

A compressible flow code that can predict the nonlinear unsteady aerodynamics associated with transonic flows over oscillating cascades is developed and validated. The code solves the two dimensional, unsteady Euler equations using a time-marching, flux-difference splitting scheme. The unsteady pressures and forces can be determined for arbitrary input motions, although only harmonic pitching and plunging motions are addressed. The code solves the flow equations on a H-grid which is allowed to deform with the airfoil motion. Predictions are presented for both flat plate cascades and loaded airfoil cascades. Results are compared to flat plate theory and experimental data. Predictions are also presented for several oscillating cascades with strong normal shocks where the pitching amplitudes, cascade geometry and interblade phase angles are varied to investigate nonlinear behavior. Author

N91-24108*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SUCKDOWN, FOUNTAIN LIFT, AND PRESSURES INDUCED ON SEVERAL TANDEM JET V/STOL CONFIGURATIONS

David C. Bellavia, Douglas A. Wardwell, Victor R. Corsiglia, and Richard E. Kuhn (STO-VL Technology, San Diego, CA.) Mar. 1991 154 p

(NASA-TM-102817; A-90144; NAS 1.15:102817) Avail: NTIS HC/MF A08 CSCL 01A

As part of a program to improve the methods for predicting the suckdown and hot gas ingestion for jet V/STOL aircraft in ground effect, a data base is being created that provides a systematic variation of parameters so that a new empirical prediction procedure can be developed. The first series of tests in this program was completed. Suckdown, fountain lift, and pressures induced on several two-jet V/STOL configurations are described. It is one of three reports that present the data obtained from tests conducted at Lockheed Aeronautical Systems-Rye Canyon Facility and in the High Bay area of the 40 by 80 foot wind tunnel complex at NASA Ames Research Center. Author

N91-24109*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.

BREAKING DOWN THE DELTA WING VORTEX: THE ROLE OF VORTICITY IN THE BREAKDOWN PROCESS Ph.D. Thesis Final Report

Robert C. Nelson and Kenneth D. Visser 1990 16 p Presented at AGARD Symposium on Vortex Flow Aerodynamics, Scheveningen, Netherlands, 1-4 Oct. 1990

(Grant NAG1-1156)

(NASA-CR-188235; NAS 1.26:188235) Avail: NTIS HC/MF A03 CSCL 01A

Experimental x-wire measurements of the flowfield above a 70 and 75 deg flat plate delta wing were performed at a Reynolds number of 250,000. Grids were taken normal to the wing at various chordwise locations for angles of attack of 20 and 30 deg. Axial and azimuthal vorticity distributions were derived from the velocity fields. The dependence of circulation on distance from the vortex core and on chordwise location was also examined. The effects of nondimensionalization in comparison with other experimental data is made. The results indicate that the circulation distribution scales with the local semispan and grows in a nearly linear fashion in the chordwise direction. The spanwise distribution of axial vorticity is severely altered through the breakdown. The axial vorticity components with a negative sense, such as that found in the secondary vortex, seem to remain unaffected by changes in wind sweep or angle of attack, in direct contrast to the positive components. In addition, the inclusion of the local wing geometry into a previously derived correlation parameter allows the circulation of growing leading edge vortex flows to be reduced into a single curve. Author

N91-24110*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.

AN EXPERIMENTAL ANALYSIS OF CRITICAL FACTORS INVOLVED IN THE BREAKDOWN PROCESS OF LEADING EDGE VORTEX FLOWS Ph.D. Thesis

Kenneth D. Visser 30 May 1991 285 p

(Grant NAG1-1156)

(NASA-CR-188231; NAS 1.26:188231) Avail: NTIS HC/MF A13 CSCL 01A

Experimental crosswire measurements of the flowfield above a 70 and 75 degree flat plate delta wing were performed at a Reynolds number of 250,000. Survey grids were taken normal to the platform at a series of chordwise locations for angles of attack of 20 and 30 degrees. Axial and azimuthal vorticity distributions were derived from the velocity fields. The dependence of circulation on distance from the vortex core as well as on chordwise location was examined. The effects of nondimensionalization in comparison

with other experimental data was made. The circulation distribution scales with the local semispan and grows approximately linearly in the chordwise direction. For regions of the flow outside of the vortex subcore, the circulation at any chordwise station was observed to vary logarithmically with distance from the vortex axis. The circulation was also found to increase linearly with angle of incidence at a given chordwise station. A reduction in the local circulation about the vortex axis occurred at breakdown. The spanwise distribution of axial vorticity was severely altered through the breakdown region and the spanwise distribution of axial vorticity present appeared to reach a maximum immediately preceding breakdown. The local concentration of axial vorticity about the vortex axis was reduced while the magnitude of the azimuthal vorticity decreased throughout the breakdown zone. The axial vorticity components with a negative sense, found in the secondary vortex, remained unaffected by changes in wing sweep or angle of attack, in direct contrast to the positive components. The inclusion of the local wing geometry into a previously derived correlation parameter indicated that the circulation of growing leading edge vortex flows were similar at corresponding radii from the vortex axis. It was concluded that the flow over a delta wing, upstream of the breakdown regions and away from the apex and trailing edge regions, is conical. In addition, the dominating factors leading to the onset of breakdown are felt to be the local circulation of the vortex and the accompanying pressure field. Author

N91-24111# Department of Transportation, Cambridge, MA. National Transportation Systems Center.
AIRCRAFT WAKE VORTICES: AN ANNOTATED BIBLIOGRAPHY (1923-1990) Final Report, Jul. - Oct. 1990
J. N. Hallock Jan. 1991 392 p
(AD-A233161; DOT-VNTSC-FAA-90-7; DOT/FAA/RD-90-30)
Avail: NTIS HC/MF A17 CSCL 01/1

This annotated bibliography consists of abstracts of publications of aircraft wake vortices. The material is arranged alphabetically by author(s) and then by month and year of publication. Experimental and theoretical articles are included and consider the formation, structure, motion, and decay of vortices and their effect on penetrating aircraft. GRA

N91-24112# Micro Craft, Inc., Tullahoma, TN.
UNSTEADY NAVIER-STOKES SOLUTIONS FOR A LOW ASPECT RATIO DELTA WING Final Report, 1 Sep. 1989 - 1 Sep. 1990
Raymond E. Gordnier Dec. 1990 33 p
(Contract F33601-89-C-0045)
(AD-A233201; WRDC-TR-90-3075) Avail: NTIS HC/MF A03 CSCL 01/1

A numerical investigation of the flow field about a 76-degree leading edge sweep delta wing at 20.5 degree angle of attack is presented. The computational results are obtained using a Beam-Warming algorithm with a Newton-like subiteration procedure. For $M = 0.2$ and $Re = 900{,}000$ an unsteady flow field is obtained which is shown to be physical in nature. The unsteady behavior is a result of the existence of small-scale vortical structures that are associated with a Kelvin-Helmholtz type instability of the shear layer emanating form the leading edge of the delta wing. The computed results show qualitative agreement with other experimental and numerical findings. GRA

N91-24113# Vigyan Research Associates, Inc., Hampton, VA.
CALCULATION OF HIGH ANGLE OF ATTACK AERODYNAMICS OF FIGHTER CONFIGURATIONS. VOLUME 1: STEADY Final Report, Aug. 1987 - Jan. 1990
C. E. Lan, H. Emdad, Suei Chin, P. Sundaram, and S. C. Mehrotra Apr. 1991 82 p
(Contract F33615-87-C-3616)
(AD-A233482; WL-TR-91-3033-Vol-1) Avail: NTIS HC/MF A05 CSCL 01/1

A computational method for lateral-directional aerodynamics of fighter configuration is developed. The leading edge vortices are represented by free vortex filaments which are adjusted iteratively to satisfy the force-free condition. The forebody vortex separation, both symmetrical and asymmetrical, is calculated using slender body theory. Effect of boundary layer separation on lifting surfaces is accounted for using the effective sectional angles of attack. The latter are obtained iteratively by matching the nonlinear sectional lift with the computed resulted based on lifting surface theory. Results for several fighter configurations are employed for comparison with available data. It is shown that the present method produces reasonable results in predicting sideslip derivatives, while role and yaw rate derivatives do not compare very well with forced oscillation test data at high angles of attack. Industrial usage of this has produced mixed results. At this time, the use of these methods in a production manner is not recommended. GRA

N91-24114# Vigyan Research Associates, Inc., Hampton, VA.
CALCULATION OF HIGH ANGLE OF ATTACK AERODYNAMICS OF FIGHTER CONFIGURATIONS. VOLUME 2: USER MANUAL FOR VORSTAB-2 Final Report, Aug. 1987 - Jan. 1990
C. E. Lan, H. Emdad, Suei Chin, P. Sundaram, and S. C. Mehrotra Apr. 1991 173 p
(Contract F33615-87-C-3616)
(AD-A233483; WL-TR-91-3033-Vol-2) Avail: NTIS HC/MF A08 CSCL 01/1

A computational method for lateral-directional aerodynamics of fighter configurations is developed. The leading-edge vortices are represented by free vortex filaments which are adjusted iteratively to satisfy the force-free condition. The forebody vortex separation, both symmetrical and asymmetrical, is calculated using slender body theory. The effect of boundary layer separation on lifting surfaces is accounted for using the effective sectional angles of attack. The latter are obtained iteratively by matching the nonlinear sectional lift with the computed results based on lifting-surface theory. Results for several fighter configurations are employed for comparison with available data. It is shown that the present method produces reasonable results in predicting sideslip derivatives, while roll- and yaw-rate derivatives do not compare very well with forced oscillation test data at high angles of attack. Industrial usage of this has produced mixed results. At this time, the use of these methods in a production manner is not recommended. GRA

N91-24115# Vigyan Research Associates, Inc., Hampton, VA.
CALCULATION OF HIGH ANGLE OF ATTACK AERODYNAMICS OF FIGHTER CONFIGURATIONS. VOLUME 3: UNSTEADY Final Report, Aug. 1987 - Jan. 1990
C. E. Lan, H. Emdad, Suei Chin, P. Sundaram, and S. C. Mehrotra Apr. 1991 59 p
(Contract F33615-87-C-3616)
(AD-A233569; WL-TR-91-3033-Vol-3) Avail: NTIS HC/MF A04 CSCL 01/1

A computational method for unsteady aerodynamics of fighter configurations at high angles of attack is developed. The leading-edge vortices are represented by free vortex filaments which are adjusted iteratively to satisfy the force-free condition. The small-disturbance, unsteady potential equation is solved in the frequency domain for motions in pitching, plunging, flapping, side movement, rolling, and yawing oscillation in compressible flow. Computed results in rolling moment coefficients due to side acceleration are compared with data for 60-deg and 80-deg delta wings. Lateral-directional characteristics for an F-106b configuration are also compared with data obtained in forced oscillation tests. It is shown that reasonable results can be obtained by the present unsteady flow method, but not by steady flow theory. Calculation of dynamic stall effects on a rectangular wing of aspect ratio 4 is demonstrated by using experimental section data. Although no data for the wing are available, the results appear plausible. Industrial usage of this has produced mixed results. At this time, the use of these methods in a production manner is recommended. GRA

N91-24116# Dayton Univ., OH. Dept. of Chemistry.
HYPERSONIC AERODYNAMICS FELLOWSHIPS Final Report, 15 Mar. 1986 - 15 Sep. 1989

John D. Anderson, Jr. 11 Feb. 1991 40 p
(Contract DAAL03-86-G-0040)
(AD-A233584; ARO-23758.2-EG-F) Avail: NTIS HC/MF A03 CSCL 20/4

This work resulted in: (1) a new approach to hypersonic waverider vehicles, which has lead to a family of waverider with exceptionally promising characteristics, and (2) the first data on the interaction of a vortex with a shock wave at hypersonic speeds. GRA

N91-24117# Army War Coll., Carlisle Barracks, PA.
AIRSHIPS AND THE MODERN MILITARY
Errol H. VanEaton 10 Mar. 1991 41 p
(AD-A233610) Avail: NTIS HC/MF A03 CSCL 01/3

The author, a dual-rated Master Army Aviator and a FAA certificated commercial airship pilot, takes a fresh look at potential application of the new generation airships to today's military missions. The paper presents a history of lighter-than-air flight. Application potential to current and projected military missions is then discussed with conclusions and recommendations offered. GRA

N91-24118*# Boeing Commercial Airplane Co., Seattle, WA.
DEVELOPING AND UTILIZING AN EULER COMPUTATIONAL METHOD FOR PREDICTING THE AIRFRAME/PROPULSION EFFECTS FOR AN AFT-MOUNTED TURBOPROP TRANSPORT. VOLUME 1: THEORY DOCUMENT Final Report
H. C. Chen and N. Y. Yu Mar. 1991 53 p
(Contract NAS1-18703)
(NASA-CR-181924-Vol-1; NAS 1.26:181924-Vol-1) Avail: NTIS HC/MF A04 CSCL 01A

An Euler flow solver was developed for predicting the airframe/propulsion integration effects for an aft-mounted turboprop transport. This solver employs a highly efficient multigrid scheme, with a successive mesh-refinement procedure to accelerate the convergence of the solution. A new dissipation model was also implemented to render solutions that are grid insensitive. The propeller power effects are simulated by the actuator disk concept. An embedded flow solution method was developed for predicting the detailed flow characteristics in the local vicinity of an aft-mounted propfan engine in the presence of a flow field induced by a complete aircraft. Results from test case analysis are presented. A user's guide for execution of computer programs, including format of various input files, sample job decks, and sample input files, is provided in an accompanying volume. Author

N91-24119*# Boeing Commercial Airplane Co., Seattle, WA.
DEVELOPING AND UTILIZING AN EULER COMPUTATIONAL METHOD FOR PREDICTING THE AIRFRAME/PROPULSION EFFECTS FOR AN AFT-MOUNTED TURBOPROP TRANSPORT. VOLUME 2: USER GUIDE Final Report
H. C. Chen, H. E. Neback, T. J. Kao, N. Y. Yu, and K. Kusunose Mar. 1991 71 p
(Contract NAS1-18703)
(NASA-CR-181924-Vol-2; NAS 1.26:181924-Vol-2) Avail: NTIS HC/MF A04 CSCL 01A

This manual explains how to use an Euler based computational method for predicting the airframe/propulsion integration effects for an aft-mounted turboprop transport. The propeller power effects are simulated by the actuator disk concept. This method consists of global flow field analysis and the embedded flow solution for predicting the detailed flow characteristics in the local vicinity of an aft-mounted propfan engine. The computational procedure includes the use of several computer programs performing four main functions: grid generation, Euler solution, grid embedding, and streamline tracing. This user's guide provides information for these programs, including input data preparations with sample input decks, output descriptions, and sample Unix scripts for program execution in the UNICOS environment. Author

N91-24120*# Boeing Commercial Airplane Co., Seattle, WA.
A GENERAL MULTIBLOCK EULER CODE FOR PROPULSION INTEGRATION. VOLUME 1: THEORY DOCUMENT Final Report
H. C. Chen, T. Y. Su, and T. J. Kao May 1991 47 p
(Contract NAS1-18703)
(NASA-CR-187484-Vol-1; NAS 1.26:187484-Vol-1) Avail: NTIS HC/MF A03 CSCL 01A

A general multiblock Euler solver was developed for the analysis of flow fields over geometrically complex configurations either in free air or in a wind tunnel. In this approach, the external space around a complex configuration was divided into a number of topologically simple blocks, so that surface-fitted grids and an efficient flow solution algorithm could be easily applied in each block. The computational grid in each block is generated using a combination of algebraic and elliptic methods. A grid generation/flow solver interface program was developed to facilitate the establishment of block-to-block relations and the boundary conditions for each block. The flow solver utilizes a finite volume formulation and an explicit time stepping scheme to solve the Euler equations. A multiblock version of the multigrid method was developed to accelerate the convergence of the calculations. The generality of the method was demonstrated through the analysis of two complex configurations at various flow conditions. Results were compared to available test data. Two accompanying volumes, user manuals for the preparation of multi-block grids (vol. 2) and for the Euler flow solver (vol. 3), provide information on input data format and program execution. Author

N91-24121*# Boeing Commercial Airplane Co., Seattle, WA.
A GENERAL MULTIBLOCK EULER CODE FOR PROPULSION INTEGRATION. VOLUME 2: USER GUIDE FOR BCON, PRE-PROCESSOR FOR GRID GENERATION AND GMBE Final Report
T. Y. Su, R. A. Appleby, and H. C. Chen May 1991 71 p
(Contract NAS1-18703)
(NASA-CR-187484-Vol-2; NAS 1.26:187484-Vol-2) Avail: NTIS HC/MF A04 CSCL 01A

The BCON is a menu-driven graphics interface program whose input consists of strings or arrays of points generated from a computer aided design (CAD) tool or any other surface geometry source. The user needs to design the block topology and prepare the surface geometry definition and surface grids separately. The BCON generates input files that contain the block definitions and the block relationships required for generating a multiblock volume grid with the EAGLE grid generation package. The BCON also generates the block boundary conditions file which is used along with the block relationship file as input for the general multiblock Euler (GMBE) code (GMBE, volumes 1 and 3). Author

N91-24122*# Boeing Commercial Airplane Co., Seattle, WA.
A GENERAL MULTIBLOCK EULER CODE FOR PROPULSION INTEGRATION. VOLUME 3: USER GUIDE FOR THE EULER CODE Final Report
H. C. Chen, T. Y. Su, and T. J. Kao May 1991 46 p
(Contract NAS1-18703)
(NASA-CR-187484-Vol-3; NAS 1.26:187484-Vol-3) Avail: NTIS HC/MF A03 CSCL 01A

This manual explains the procedures for using the general multiblock Euler (GMBE) code developed under NASA contract NAS1-18703. The code was developed for the aerodynamic analysis of geometrically complex configurations in either free air or wind tunnel environments (vol. 1). The complete flow field is divided into a number of topologically simple blocks within each of which surface fitted grids and efficient flow solution algorithms can easily be constructed. The multiblock field grid is generated with the BCON procedure described in volume 2. The GMBE utilizes a finite volume formulation with an explicit time stepping scheme to solve the Euler equations. A multiblock version of the multigrid method was developed to accelerate the convergence of the calculations. This user guide provides information on the GMBE code, including input data preparations with sample input files and a sample Unix script for program execution in the UNICOS environment. Author

N91-24123*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
THEORETICAL EVALUATION OF ENGINE AUXILIARY INLET DESIGN FOR SUPERSONIC V/STOL AIRCRAFT Final Report
Michael A. Boles and Richard L. Heavner Cleveland, OH NASA May 1991 97 p
(Grant NAG3-608)
(NASA-CR-187098; NAS 1.26:187098) Avail: NTIS HC/MF A05 CSCL 01A

A higher order panel method is used to evaluate the potential flow of a 2-D supersonic V/STOL inlet. A nonsymmetric analytical inlet model is developed to closely match a wind tunnel model tested at NASA-Lewis. The analytical inlet used is analyzed for flow characteristics around the lower cowl lip and auxiliary inlets. The results for this analysis are obtained for the output of a computer program produced by the McDonnell Douglas Corp. This program is based on the Hess Panel Method which determines source strengths of panel distributed over a 3-D body. The analytical model was designed for the implementation of a drooped/translated cowl lip and auxiliary inlets as flow improvement concepts. A 40 or 70 deg droop lip can be incorporated on the inlet to determine if these geometry changes result in flow improvements which may reduce the propensity for flow separation on the interior portion of the lip. Auxiliary inlets are used to decrease the mass flow over the inlet lip; thus, the peak flow velocity is reduced at the lip which also lessens the likelihood of flow separation on the interior portion of the lip. A 2, 4, and 6 in. translated lip can be used to also decrease mass flow over the inlet lower lip in the same manner. Author

N91-24124*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THREE-DIMENSIONAL EULER TIME ACCURATE SIMULATIONS OF FAN ROTOR-STATOR INTERACTIONS
A. A. Boretti (Fiat Research Center, Orbassano, Turin, Italy) Dec. 1990 30 p
(NASA Order C-99066-G)
(NASA-TM-102528; ICOMP-90-08; E-5338; NAS 1.15:102528) Avail: NTIS HC/MF A03 CSCL 01A

A numerical method useful to describe unsteady 3-D flow fields within turbomachinery stages is presented. The method solves the compressible, time dependent, Euler conservation equations with a finite volume, flux splitting, total variation diminishing, approximately factored, implicit scheme. Multiblock composite gridding is used to partition the flow field into a specified arrangement of blocks with static and dynamic interfaces. The code is optimized to take full advantage of the processing power and speed of the Cray Y/MP supercomputer. The method is applied to the computation of the flow field within a single stage, axial flow fan, thus reproducing the unsteady 3-D rotor-stator interaction. Author

N91-24125*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
IMPLICIT SOLVERS FOR UNSTRUCTURED MESHES Final Report
V. Venkatakrishnan (Computer Sciences Corp., Moffett Field, CA.) and Dimitri J. Mavriplis May 1991 24 p
(Contract NAS1-18605)
(NASA-CR-187564; NAS 1.26:187564; ICASE-91-40) Avail: NTIS HC/MF A03 CSCL 01A

Implicit methods were developed and tested for unstructured mesh computations. The approximate system which arises from the Newton linearization of the nonlinear evolution operator is solved by using the preconditioned GMRES (Generalized Minimum Residual) technique. Three different preconditioners were studied, namely, the incomplete LU factorization (ILU), block diagonal factorization, and the symmetric successive over relaxation (SSOR). The preconditioners were optimized to have good vectorization properties. SSOR and ILU were also studied as iterative schemes. The various methods are compared over a wide range of problems. Ordering of the unknowns, which affects the convergence of these sparse matrix iterative methods, is also studied. Results are presented for inviscid and turbulent viscous calculations on single and multielement airfoil configurations using globally and adaptively generated meshes. Author

N91-24126*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
HIGH-ORDER ENO SCHEMES APPLIED TO TWO- AND THREE-DIMENSIONAL COMPRESSIBLE FLOW Final Report
Chi-Wang Shu, Gordon Erlebacher, Thomas A. Zang, David Whitaker, and Stanley Osher (California Univ., Los Angeles.) Apr. 1991 45 p Submitted for publication
(Contracts NAS1-18605; NAG1-1145; NAG1-270; NSF DMS-88-10150; NSF DMS-88-11863; AF-AFOSR-0093-90; N00014-86-K-0691)
(NASA-CR-187562; NAS 1.26:187562; ICASE-91-38) Avail: NTIS HC/MF A03 CSCL 01A

High order essentially non-oscillatory (ENO) finite difference schemes are applied to the 2-D and 3-D compressible Euler and Navier-Stokes equations. Practical issues, such as vectorization, efficiency of coding, cost comparison with other numerical methods, and accuracy degeneracy effects, are discussed. Numerical examples are provided which are representative of computational problems of current interest in transition and turbulence physics. These require both nonoscillatory shock capturing and high resolution for detailed structures in the smooth regions and demonstrate the advantage of ENO schemes. Author

N91-24127*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
NONLINEAR DEVELOPMENT AND SECONDARY INSTABILITY OF GORTLER VORTICES IN HYPERSONIC FLOWS Final Report
Yibin B. Fu and Philip Hall (Manchester Univ., England) May 1991 48 p Submitted for publication Sponsored in cooperation with the Science and Engineering Research Council
(Contract NAS1-18605; AF-AFOSR-0042-89)
(NASA-CR-187563; NAS 1.26:187563; ICASE-91-39) Avail: NTIS HC/MF A03 CSCL 01A

In a hypersonic boundary layer over a wall of variable curvature, the region most susceptible to Goertler vortices is the temperature adjustment layer over which the basic state temperature decreases monotonically to its free stream value. Except for a special wall curvature distribution, the evolution of Goertler vortices trapped in the temperature adjustment layer will in general be strongly affected by the boundary layer growth through the O(M sup 3/2) curvature of the basic state, where M is the free stream Mach number. Only when the local wavenumber becomes as large as of order M sup 3/8, do nonparallel effects become negligible in the determination of stability properties. In the latter case, Goertler vortices will be trapped in a thin layer of O(epsilon sup 1/2) thickness which is embedded in the temperature adjustment layer; here epsilon is the inverse of the local wavenumber. A weakly nonlinear theory is presented in which the initial nonlinear development of Goertler vortices in the neighborhood of the neutral position is studied and two coupled evolution equations are derived. From these, it can be determined whether the vortices are decaying or growing depending on the sign of a constant which is related to wall curvature and the basic state temperature. Author

N91-24128*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FLOW VISUALIZATION STUDY OF A 1/48-SCALE AFTI/F111 MODEL TO INVESTIGATE HORIZONTAL TAIL FLOW DISTURBANCES
Lisa J. Bjarke Jun. 1991 35 p Original contains color illustrations
(NASA-TM-101698; H-1547; NAS 1.15:101698) Avail: NTIS HC/MF A03; 24 functional color pages CSCL 01A

During flight testing of the AFTI/F111 aircraft, horizontal tail buffet was observed. Flutter analysis ruled out any aeroelastic instability, so a water-tunnel flow visualization study was conducted to investigate possible flow disturbances on the horizontal tail which might cause buffet. For this study, a 1/48-scale model was used.

Four different wing cambers and one horizontal tail setting were tested between 0 and 20 deg angle of attack. These wing cambers corresponded to the following leading training edge deflections: 0/2, 10/10, 10/2, and 0/10. Flow visualization results in the form of still photographs are presented for each of the four wing cambers between 8 and 12 deg angle of attack. In general, the horizontal tail experiences flow disturbances which become more pronounced with angle of attack or wing trailing-edge deflection. Author

N91-24129*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF NOZZLE EXIT GEOMETRY AND PRESSURE RATIO ON PLUME SHAPE FOR NOZZLES EXHAUSTING INTO QUIESCENT AIR
William I. Scallion May 1991 37 p
(NASA-TM-104097; NAS 1.15:104097) Avail: NTIS HC/MF A03 CSCL 01A

The effects of varying the exit geometry on the plume shapes of supersonic nozzles exhausting into quiescent air at several exit-to-ambient pressure ratios are given. Four nozzles having circular throat sections and circular, elliptical and oval exit cross sections were tested and the exit plume shapes are compared at the same exit-to-ambient pressure ratios. The resulting mass flows were calculated and are also presented. Author

N91-24130*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE 3-D NAVIER-STOKES ANALYSIS OF CROSSING, GLANCING SHOCKS/TURBULENT BOUNDARY LAYER INTERACTIONS
D. R. Reddy 1991 14 p Presented at the 22nd Fluid Dynamics, Plasma Dynamics and Lasers Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(NASA-TM-104469; E-6318; NAS 1.15:104469; AIAA-91-1758)
Avail: NTIS HC/MF A03 CSCL 01A

Three dimensional viscous flow analysis is performed for a configuration where two crossing and glancing shocks interact with a turbulent boundary layer. A time marching 3-D full Navier-Stokes code, called PARC3D, is used to compute the flow field, and the solution is compared to the experimental data obtained at the NASA Lewis Research Center's 1 x 1 ft supersonic wind tunnel facility. The study is carried out as part of the continuing code assessment program in support of the generic hypersonic research at NASA Lewis. Detailed comparisons of static pressure fields and oil flow patterns are made with the corresponding solution on the wall containing the shock/boundary layer interaction in an effort to validate the code for hypersonic inlet applications.
Author

N91-24131*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A DESIGN STRATEGY FOR THE USE OF VORTEX GENERATORS TO MANAGE INLET-ENGINE DISTORTION USING COMPUTATIONAL FLUID DYNAMICS
Bernhard H. Anderson and Ralph Levy (Scientific Research Associates, Inc., Glastonbury, CT.) 1991 36 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104436; E-6275; NAS 1.15:104436; AIAA-91-2474)
Avail: NTIS HC/MF A03 CSCL 01A

A reduced Navier-Stokes solution technique was successfully used to design vortex generator installations for the purpose of minimizing engine face distortion by restructuring the development of secondary flow that is induced in typical 3-D curved inlet ducts. The results indicate that there exists an optimum axial location for this installation of corotating vortex generators, and within this configuration, there exists a maximum spacing between generator blades above which the engine face distortion increases rapidly. Installed vortex generator performance, as measured by engine face circumferential distortion descriptors, is sensitive to Reynolds number and thereby the generator scale, i.e., the ratio of generator blade height to local boundary layer thickness. Installations of corotating vortex generators work well in terms of minimizing engine face distortion within a limited range of generator scales. Hence, the design of vortex generator installations is a point design, and all other conditions are off design. In general, the loss levels associated with a properly designed vortex generator installation are very small; thus, they represent a very good method to manage engine face distortion. This study also showed that the vortex strength, generator scale, and secondary flow field structure have a complicated and interrelated influence over engine face distortion, over and above the influence of the initial arrangement of generators. Author

N91-24132*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRANSONIC SYMPOSIUM: THEORY, APPLICATION AND EXPERIMENT, VOLUME 2
Jerome T. Foughner, Jr., comp. Apr. 1989 241 p Symposium held in Hampton, VA, 19-21 Apr. 1988
(NASA-CP-3020-Vol-2; L-16502-Vol-2; NAS 1.55:3020-Vol-2)
Avail: NTIS HC/MF A11 CSCL 01A

Papers presented at the Transonic Symposium are compiled. The following subject areas are covered: National Transonic Facility status; transonic aerodynamics of slender wing-body configuration; laminar flow flight experiments; laminar flow wind tunnel experiments; computational support of X-29A flight experiment; transition location on a clean-up glove installed on a F-14 aircraft; and design studies for a laminar glove for the X-29 aircraft. For individual titles, see N91-24133 through N91-24138.

N91-24133*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NATIONAL TRANSONIC FACILITY STATUS **c09**
L. W. McKinney, W. E. Bruce, Jr., and B. B. Gloss *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 1-39 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 14B

The National Transonic Facility (NTF) was operational in a combined checkout and test mode for about 3 years. During this time there were many challenges associated with movement of mechanical components, operation of instrumentation systems, and drying of insulation in the cryogenic environment. Most of these challenges were met to date along with completion of a basic flow calibration and aerodynamic tests of a number of configurations. Some of the major challenges resulting from cryogenic environment are reviewed with regard to hardware systems and data quality. Reynolds number effects on several configurations are also discussed. Author

N91-24134*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REYNOLDS NUMBER EFFECTS ON THE TRANSONIC AERODYNAMICS OF A SLENDER WING-BODY CONFIGURATION
James M. Luckring, Charles H. Fox, Jr., and Jeffrey S. Cundiff (George Washington Univ., Hampton, VA.) *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 41-58 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 01A

Aerodynamic forces and moments for a slender wing-body configuration are summarized from an investigation in the Langley National Transonic Facility (NTF). The results include both longitudinal and lateral-directional aerodynamic properties as well as slideslip derivatives. Results were selected to emphasize Reynolds number effects at a transonic speed although some lower speed results are also presented for context. The data indicate nominal Reynolds number effects on the longitudinal aerodynamic coefficients and more pronounced effects for the lateral-directional aerodynamic coefficients. The Reynolds number sensitivities for the lateral-directional coefficients were limited to high angles of attack. Author

N91-24135*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LAMINAR-FLOW FLIGHT EXPERIMENTS
Richard D. Wagner, Dal V. Maddalon, D. W. Bartlett, F. S. Collier, Jr., and A. L. Braslow (Analytical Services and Materials, Inc., Hampton, VA.) *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 59-104 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 01A

The flight testing conducted over the past 10 years in the NASA laminar-flow control (LFC) will be reviewed. The LFC program was directed towards the most challenging technology application, the high supersonic speed transport. To place these recent experiences in perspective, earlier important flight tests will first be reviewed to recall the lessons learned at that time. Author

N91-24136*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LAMINAR-FLOW WIND TUNNEL EXPERIMENTS
William D. Harvey, Charles D. Harris, William G. Sewall, and John P. Stack *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 105-145 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 01A

Although most of the laminar flow airfoils recently developed at the NASA Langley Research Center were intended for general aviation applications, low-drag airfoils were designed for transonic speeds and wind tunnel performance tested. The objective was to extend the technology of laminar flow to higher Mach and Reynolds numbers and to swept leading edge wings representative of transport aircraft to achieve lower drag and significantly improved operation costs. This research involves stabilizing the laminar boundary layer through geometric shaping (Natural Laminar Flow, NLF) and active control involving the removal of a portion of the laminar boundary layer (Laminar-Flow Control, LFC), either through discrete slots or perforated surface. Results show that extensive regions of laminar flow with large reductions in skin friction drag can be maintained through the application of passive NLF boundary-layer control technologies to unswept transonic wings. At even greater extent of laminar flow and reduction in the total drag level can be obtained on a swept supercritical airfoil with active boundary layer-control. Author

N91-24137*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL SUPPORT OF THE X-29A ADVANCED TECHNOLOGY DEMONSTRATOR FLIGHT EXPERIMENT c05
E. G. Waggoner and B. L. Bates (Vigyan Research Associates, Inc., Hampton, VA.) *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 147-166 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 01C

Issues and questions associated with the forward swept wing and closely coupled canard are addressed. The primary focus will be on research questions which must be addressed to obtain high quality ground and flight test data. These data will be used in conjunction with computational predictions to complement the analyses required to comprehensively understand the interacting technologies. Author

N91-24138*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RESULTS OF CORRELATIONS FOR TRANSITION LOCATION ON A CLEAN-UP GLOVE INSTALLED ON AN F-14 AIRCRAFT AND DESIGN STUDIES FOR A LAMINAR GLOVE FOR THE X-29 AIRCRAFT ACCOUNTING FOR SPANWISE PRESSURE GRADIENT c05
S. H. Goradia (Vigyan Research Associates, Inc., Hampton, VA.), P. J. Bobbitt, H. L. Morgan, J. C. Ferris, and William D. Harvey *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 167-227 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 01A

Results of correlative and design studies for transition location, laminar and turbulent boundary-layer parameters, and wake drag for forward swept and aft swept wings are presented. These studies were performed with the use of an improved integral-type boundary-layer and transition-prediction methods. Theoretical predictions were compared with flight measurements at subsonic and transonic flow conditions for the variable aft swept wing F-14 aircraft for which experimental pressure distributions, transition locations, and turbulent boundary-layer velocity profiles were measured. Flight data were available at three spanwise stations for several values of sweep, freestream unit Reynolds number, Mach numbers, and lift coefficients. Theory/experiment correlations indicate excellent agreement for both transition location and turbulent boundary-layer parameters. The results of parametric studies performed during the design of a laminar glove for the forward swept wing X-29 aircraft are also presented. These studies include the effects of a spanwise pressure gradient on transition location and wake drag for several values of freestream Reynolds numbers at a freestream Mach number of 0.9. Author

N91-24139*# Boeing Commercial Airplane Co., Seattle, WA.
VARIABLE SWEEP TRANSITION FLIGHT EXPERIMENT (VSTFE): UNIFIED STABILITY SYSTEM (USS). DESCRIPTION AND USERS' MANUAL Report, Oct. 1985 - May 1990
Rodger A. Rozendaal and Roxanna Behbehani Jun. 1990 124 p
(Contract NAS1-15325)
(NASA-CR-181918; NAS 1.26:181918; D6-54961) Avail: NTIS HC/MF A06 CSCL 01A

NASA initiated the Variable Sweep Transition Flight Experiment (VSTFE) to establish a boundary layer transition database for laminar flow wing design. For this experiment, full-span upper surface gloves were fitted to a variable sweep F-14 aircraft. The development of an improved laminar boundary layer stability analysis system called the Unified Stability System (USS) is documented and results of its use on the VSTFE flight data are shown. The USS consists of eight computer codes. The theoretical background of the system is described, as is the input, output, and usage hints. The USS is capable of analyzing boundary layer stability over a wide range of disturbance frequencies and orientations, making it possible to use different philosophies in calculating the growth of disturbances on sweptwings. Author

N91-24290# Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
SHOCK WAVE/BOUNDARY LAYER INTERACTION CONTROL IN A GENERIC HYPERSONIC INLET
M. E. White, R. E. Lee, B. D. Couch, and P. Galambos (General Dynamics Corp., Fort Worth, TX.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 235-246 (For primary document see N91-24273 16-20)
(Contract N00039-89-C-0001)
Avail: NTIS HC/MF A20

03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

N91-24140*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS: THIRD COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 2
Dan D. Vicroy, comp., Roland L. Bowles, comp., and Herbert Schlickenmaier, comp. (Federal Aviation Administration, Washington, DC.) Jan. 1991 464 p Conference held in Hampton, VA, 16-18 Oct. 1990 Prepared in cooperation with

Federal Aviation Administration, Washington, DC
(NASA-CP-10060-Pt-2; NAS 1.55:10060-Pt-2;
DOT/FAA/RD-91/2-Pt-2) Avail: NTIS HC/MF A20 CSCL 01C

The Third Combined Manufacturers' and Technologists' Conference was held in Hampton, Va., on October 16-18, 1990. The purpose of the meeting was to transfer significant on-going results of the NASA/FAA joint Airborne Wind Shear Program to the technical industry and to pose problems of current concern to the combined group. It also provided a forum for manufacturers to review forward-look technology concepts and for technologists to gain an understanding of the problems encountered by the manufacturers during the development of airborne equipment and the FAA certification requirements. For individual titles, see N91-24141 through N91-24156.

N91-24141*# Lockheed Missiles and Space Co., Palo Alto, CA.
CLASS: COHERENT LIDAR AIRBORNE SHEAR SENSOR. WINDSHEAR AVOIDANCE
Russell Targ *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 509-526 (For primary document see N91-24140 16-03)
(LMSC-F-415048) Avail: NTIS HC/MF A20 CSCL 01C

The coherent lidar airborne shear sensor (CLASS) is an airborne CO2 lidar system being designed and developed by Lockheed Missiles and Space Company, Inc. (LMSC) under contract to NASA Langley Research Center. The goal of this program is to develop a system with a 2- to 4-kilometer range that will provide a warning time of 20 to 40 seconds, so that the pilot can avoid the hazards of low-altitude wind shear under all weather conditions. It is a predictive system which will warn the pilot about a hazard that the aircraft will experience at some later time. The ability of the system to provide predictive warnings of clear air turbulence will also be evaluated. A one-year flight evaluation program will measure the line-of-sight wind velocity from a wide variety of wind fields obtained by an airborne radar, an accelerometer-based reactive wind-sensing system, and a ground-based Doppler radar. The success of the airborne lidar system will be determined by its correlation with the windfield as indicated by the onboard reactive system, which indicates the winds actually experienced by the NASA Boeing 737 aircraft. Author

N91-24142*# Ophir Corp., Lakewood, CO.
CONTINUOUS WAVE LASER FOR WIND SHEAR DETECTION
Loren Nelson *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 527-554 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

Details of the design and development of a continuous-wave heterodyne carbon dioxide laser which has wind shear detection capabilities are given in viewgraph form. The goal of the development was to investigate the lower cost CW (rather than pulsed) lidar option for look-ahead wind shear detection from aircraft. The device has potential utility for ground based wind shear detection at secondary airports where the high cost of a Terminal Doppler Weather Radar system is not justifiable. Author

N91-24143*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STATUS OF 2 MICRON LASER TECHNOLOGY PROGRAM
Mark Storm *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 555-576 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

The status of 2 micron lasers for windshear detection is described in viewgraph form Theoretical atmospheric and instrument system studies have demonstrated that the 2.1 micron Ho:YAG lasers can effectively measure wind speeds in both wet and dry conditions with accuracies of 1 m/sec. Two micron laser technology looks very promising in the near future, but several technical questions remain. The Ho:YAG laser would be small, compact, and efficient, requiring little or no maintenance. Since the Ho:YAG laser is laser diode pumped and has no moving part, the lifetime of this laser would be directly related to the diode laser lifetimes which can perform in excess of 10,000 hours. Efficiencies of 3 to 12 percent are expected, but laser demonstrations confirming the ability to Q-switch this laser are required. Coherent laser operation has been demonstrated for both the CW and Q-switched lasers. Author

N91-24144*# Litton Aero Products, Moorpark, CA.
AVIONIC LASER MULTISENSOR PROGRAM AT LITTON AERO PRODUCTS
Rod Benoist and Farzin Amzajerdian *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 577-586 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

Information on the Avionic Laser Multisensor program at Litton Aero Products is given in viewgraph form. Included are project goals, potential avionic applications, and future work. Author

N91-24145*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STATUS OF NASA'S IR WIND SHEAR DETECTION RESEARCH
Burnell McKissick *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 589-608 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

The status of NASA's wind shear detection research is reported in viewgraph form. Information is given on early experience, FLIR detectors, quantities measured by Airborne Warning and Avoidance System 1 (AWAS 1), the time series model for Flight 551, conclusions from NASA 737 flights, conclusions on Orlando 7-7-90, and AWAS 3 mnemonics. Author

N91-24146*# Turbulence Prediction Systems, Boulder, CO.
STATUS OF TURBULENCE PREDICTION SYSTEM'S AWAS 3
Pat Adamson *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 609-635 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

The status of the Airborne Warning and Avoidance System 3 (AWAS 3) is reported in viewgraph form. Information is given on flight tests and FAA certification. Included is a description of the flight test of a passive infrared system that achieved the first ever advanced warning of an in-flight windshear encounter. The infrared system recorded the detection of the windshear with a 35 second advance warning. The data recorded in-flight by the infrared system was later compared to and found to agree with the data recorded by the Terminal Doppler Weather Radar (TDWR) and the in-situ air data. Author

N91-24147*# Colorado State Univ., Fort Collins.
AN AIRBORNE FLIR DETECTION AND WARNING SYSTEM FOR LOW ALTITUDE WIND SHEAR
Peter C. Sinclair and Peter M. Kuhn (Aries Corp., McLean, VA.) *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 637-677 Submitted for publication (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

It is shown through some preliminary flight measurement research that a forward looking infrared radiometer (FLIR) system

can be used to successfully detect the cool downdraft of downbursts (microbusts/macrobursts) and thunderstorm gust front outflows that are responsible for most of the low altitude wind shear (LAWS) events. The FLIR system provides a much greater safety margin for the pilot than that provided by reactive designs such as inertial air speed systems. Preliminary results indicate that an advanced airborne FLIR system could provide the pilot with remote indication of microburst (MB) hazards along the flight path ahead of the aircraft. Results of a flight test of a prototype FLIR system show that a minimum warning time of one to four minutes (5 to 10 km), depending on aircraft speed, is available to the pilot prior to the microburst encounter. Author

N91-24148*# Delco Systems Operations, Milwaukee, WI.
FORWARD LOOKING WIND SHEAR DETECTION PROGRAM
Brian Gallagher and Mark Selogie (Hughes Aircraft Co., Los Angeles, CA.) *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 679-712 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

Delco Systems' Forward Looking Windshear Detection program is reviewed in viewgraph form. Topics covered include extinction of radiance by absorbing and scattering media, atmospheric absorption in the far infrared region, an inframetrics imaging radiometer, a basic radiance signal equation, and tower and flight test plans. Author

N91-24149*# Westinghouse Defense and Electronic Systems Center, Baltimore, MD. Radar Systems Engineering.
SABERLINER FLIGHT TEST FOR AIRBORNE WIND SHEAR FORWARD LOOKING DETECTION AND AVOIDANCE RADAR SYSTEMS
Bruce D. Mathews *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 713-754 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

Westinghouse conducted a flight test with its Sabreliner AN/APG-68 instrumented radar to assess the urban discrete/ground moving vehicle clutter environment. Glideslope approaches were flown into Washington National, BWI, and Georgetown, Delaware, airports employing radar mode timing, waveform, and processing configurations plausible for microburst windshear avoidance. The perceptions, both general and specific, of the clutter environment furnish an empirical foundation for beginning low false alarm detection algorithm development. Author

N91-24150*# Allied-Signal Aerospace Co., Fort Lauderdale, FL. Air Transport Avionics Div.
DOPPLER WEATHER RADAR WITH PREDICTIVE WIND SHEAR DETECTION CAPABILITIES
Daryal Kuntman *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 755-766 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

The status of Bendix research on Doppler weather radar with predictive wind shear detection capability is given in viewgraph form. Information is given on the RDR-4A, a fully coherent, solid state transmitter having Doppler turbulence capability. Frequency generation data, plans, modifications, system characteristics and certification requirements are covered. Author

N91-24151*# Rockwell International Corp., Cedar Rapids, IA. Air Transport Div.
WIND SHEAR RADAR PROGRAM FUTURE PLANS
Roy E. Robertson *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 767-781 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

The status of the Windshear Radar Program at the Collins Air Transport Division of Rockwell International is given in viewgraph form. Topics covered include goals, modifications to the WXR-700 system, flight test plans, technical approaches, design considerations, system considerations, certification, and future plans. Author

N91-24152*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CLUTTER MODELING OF THE DENVER AIRPORT AND SURROUNDING AREAS
Steven D. Harrah, Victor E. Delmore, and Robert G. Onstott (Environmental Research Inst. of Michigan, Ann Arbor.) *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 783-836 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

To accurately simulate and evaluate an airborne Doppler radar as a wind shear detection and avoidance sensor, the ground clutter surrounding a typical airport must be quantified. To do this, an imaging airborne Synthetic Aperture Radar (SAR) was employed to investigate and map the normalized radar cross sections (NRCS) of the ground terrain surrounding the Denver Stapleton Airport during November of 1988. Images of the Stapleton ground clutter scene were obtained at a variety of aspect and elevation angles (extending to near-grazing) at both HH and VV polarizations. Presented here, in viewgraph form with commentary, are the method of data collection, the specific observations obtained of the Denver area, a summary of the quantitative analysis performed on the SAR images to date, and the statistical modeling of several of the more interesting stationary targets in the SAR database. Additionally, the accompanying moving target database, containing NRCS and velocity information, is described. Author

N91-24153*# Research Triangle Inst., Newport News, VA.
RADAR SIMULATION PROGRAM UPGRADE AND ALGORITHM DEVELOPMENT
Charles L. Britt *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 839-867 (For primary document see N91-24140 16-03)
(Contract NAS1-18925)
Avail: NTIS HC/MF A20 CSCL 01C

The NASA Radar Simulation Program is a comprehensive calculation of the expected output of an airborne coherent pulse Doppler radar system viewing a low level microburst along or near the approach path. Inputs to the program include the radar system parameters and data files that contain the characteristics of the microbursts to be simulated, the ground clutter map, and the discrete target data base which provides a simulation of the moving ground clutter. For each range bin, the simulation calculates the received signal amplitude level by integrating the product of the antenna gain pattern and the scattering source amplitude and phase of a spherical shell volume segment defined by the pulse width, radar range, and ground plane intersection. A series of in-phase and quadrature pulses are generated and stored for further processing if desired. In addition, various signal processing techniques are used to derive the simulated velocity and hazard measurements, and store them for use in plotting and display programs. Author

N91-24154*# Clemson Univ., SC. Radar Systems Lab.
SIGNAL PROCESSING TECHNIQUES FOR CLUTTER FILTERING AND WIND SHEAR DETECTION
Ernest G. Baxa, Jr. and Manohar D Deshpande *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and

Technologists' Conference, Part 2 Jan. 1991 p 869-911 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

An extended Prony algorithm applicable to signal processing techniques for clutter filtering and windshear detection is discussed. The algorithm is based upon modelling the radar return as a time series, and appears to offer potential for improving hazard factor estimates in the presence of strong clutter returns. Author

N91-24155*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE RADAR SIMULATION STUDIES OF THE DENVER JULY 11, 1988 MICROBURST
Charles L. Britt (Research Triangle Inst., Newport News, VA.) and E. M. Bracalente *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 913-936 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

In the simulation program, a wind shear detection Doppler radar was placed in UAL 395 and 236 aircraft and flown along their landing flight paths. The microburst was placed at the appropriate location and intensity corresponding to each aircraft's landing approach time. A baseline set of radar design parameters were used in the simulation. Output display information and wind shear detection processing was produced as the aircraft approached the microburst. Information on the results of the simulation study are given in graphical form. Author

N91-24156*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESCRIPTION, CHARACTERISTICS AND TESTING OF THE NASA AIRBORNE RADAR
W. R. Jones, O. Altiz, P. Schaffner, J. H. Schrader (Research Triangle Inst., Newport News, VA.), and H. J. C. Blume *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 Jan. 1991 p 937-978 (For primary document see N91-24140 16-03)
Avail: NTIS HC/MF A20 CSCL 01C

Presented here is a description of a coherent radar scattermeter and its associated signal processing hardware, which have been specifically designed to detect microbursts and record their radar characteristics. Radar parameters, signal processing techniques and detection algorithms, all under computer control, combine to sense and process reflectivity, clutter, and microburst data. Also presented is the system's high density, high data rate recording system. This digital system is capable of recording many minutes of the in-phase and quadrature components and corresponding receiver gains of the scattered returns for selected spatial regions, as well as other aircraft and hardware related parameters of interest for post-flight analysis. Information is given in viewgraph form. Author

N91-24157# Wichita State Univ., KS. National Inst. for Aviation Research.
PROGRAM PLANS FOR AVIATION SAFETY RESEARCH
William H. Wentz, John J. Hutchinson, Behnam Bahr, Wayne Becker, Walter Bernhart, Randall M. Chambers, Richard Chandler (Federal Aviation Administration, Atlantic City, NJ.), Thomas K. DeLillo, David Ellis, and James Ho et al Dec. 1990 62 p
(Contract DTFA03-90-C-00050)
(NIAR-90-32) Avail: NTIS HC/MF A04

The National Institute for Aviation research at the Wichita State University is conducting research in aviation safety for the Federal Aviation Administration (FAA). The research activities are in the three major areas of aging aircraft, crashworthiness and structural integrity, and human factors. Specific topics include crack detection in aircraft structures, scratch effects on fatigue of new alloys, crash analysis of aircraft seats, paint removal for composite aircraft structures, freeze/thaw damage to composites, and single pilot instrument flight rules (IFR) operations. For individual titles, see N91-24158 through N91-24165.

N91-24158# Wichita State Univ., KS.
FEASIBILITY STUDY IN CRACK DETECTION IN AIRCRAFT STIFFENED PANELS BY PULSE PROBING AND DECONVOLUTION **c05**
Jorge E. Talia, Behnam Bahr, and Hamid M. Lankarani *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

The main objective is to assess the use of changes in dynamic characteristics of a structure or its spectroscopy to detect crack formation. The first approach is to excite the structure harmonically over a range of frequencies and recover the natural frequencies of vibration and modal damping parameters from the analysis of the steady state responses. The preferred approach is to excite the structure with an appropriate pulse and extract the dynamic Green's function from the corresponding transient response. Author

N91-24159# Wichita State Univ., KS.
THE EFFECT OF SURFACE GENERATED SCRATCHES ON THE FATIGUE LIFE OF AEROSPACE MATERIALS **c26**
Jorge E. Talia, Behnam Bahr, and Hamid M. Lankarani *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

The objective of this proposed investigation is to study the effect that small surface generated scratches have on the cyclic deformation as well as the crack nucleation and propagation behavior of aluminum alloy polycrystals, particularly under low cycle fatigue conditions. Experiments will provide information on the relevant deformation and fracture resistance parameters such as cyclic stress strain curve, number of cycles required to generate a surface crack of certain length, and number of cycles to failure, while indicating the dependence of these parameters on the applied stress. The fatigue properties will be correlated with micro-structural defects to study the modes and mechanisms of the influence of scratches on crack formation and growth. Author

N91-24160# Wichita State Univ., KS.
BONDED/FUSION REPAIR OF AIRCRAFT STRUCTURES **c01**
Wayne Becker and James Ho *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

The objective is to quantify a procedure for assessment and repair of aircraft metallic and composite structures which will provide reliable, consistent results with minimal downtime. The technical approach and project management and coordination are briefly discussed. Author

N91-24161# Wichita State Univ., KS.
CRASHWORTHINESS EXPERIMENTS
Wayne Bernhart, Howard Smith, Richard Chandler, and Joseph Mitchell *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

The Wichita State University purchased a horizontal impact sled. The sled is currently being subjected to various acceptance tests. The primary objective of this research program is to complete the development of a total dynamic test capability to support elements of the aircraft industry in meeting future and present FAA regulatory standards. The FAA has developed these regulatory standards for seats and restraint systems and is expected to issue new standards for various aircraft components. It is anticipated that the FAA will conduct various dynamic tests in this laboratory in support of their own program in crashworthiness. Author

N91-24162# Wichita State Univ., KS.
ANALYSIS OF COMMUTER AIRCRAFT SEAT-TYPE STRUCTURES IN A CRASH ENVIRONMENT
Steven J. Hooper and Thomas K. DeLillo *In its* Program Plans for Aviation Safety Research Dec. 1990 8 p (For primary

document see N91-24157 16-03)
Avail: NTIS HC/MF A04

The objective of this project is to initiate the development of an analysis capability for seat structures subject to a crash accident. This project will assess the performance of the SOM-LA computer program in terms of its capability to accurately analyze this problem. The project will also develop an interface between this analysis program and the data acquisition software used in the Impact Sled Laboratory at the National Institute for Aviation Research at Wichita State University. Author

N91-24163# Wichita State Univ., KS.
MECHANICAL PAINT REMOVAL TECHNIQUES FOR COMPOSITE AIRCRAFT **c01**
Jorge E. Talia, Behnam Bahr, Wayne Becker, and Hamid M. Lankarani *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

The use of conventional paint removal on composite material can lead to a fast deterioration or weakening of the material due to the absorption and chemical attack of the solvent which may result in a catastrophic failure of the structure. Moreover, recent EPA regulations ban the use of solvents for paint removal on land and sea military bases. The objective is to investigate the possibilities of paint removal by mechanical techniques, specifically by the impingement of solid particles, a technique that would not leave structural damage on the treated material and would not effect the environment. Author

N91-24164# Wichita State Univ., KS.
THE EFFECTS OF FREEZE/THAW CYCLES ON BONDED JOINTS AND COMPOSITE MATERIALS
Steven J. Hooper *In its* Program Plans for Aviation Safety Research Dec. 1990 7 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

The objective is to develop a test method that can be used to assess the structural integrity of bonded joints and composite materials subject to mechanical loads and the environmental effects due to moisture intrusion and subsequent freeze/thaw cycles. The effects of both static loading and fatigue loading will be investigated. Author

N91-24165# Wichita State Univ., KS.
HUMAN FACTORS COCKPIT: A SYSTEM AND HUMAN FACTORS PROGRAM TO ENHANCE SAFETY AND EFFICIENCY IN SINGLE PILOT IFR AND TERMINAL AREA OPERATIONS **c54**
Randall M. Chambers, Paul York, M. Gawad Nagati, and David Ellis *In its* Program Plans for Aviation Safety Research Dec. 1990 11 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

The objective is to study the interrelationships between the pilot, the aircraft, and its on-board flight control and avionics systems in an effort to determine how best to apply these new technologies. The accomplishment of this objective requires the development of the required navigation, display, and simulation system components. Author

N91-24166*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS: THIRD COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 1
Dan D. Vicroy, comp., Roland L. Bowles, comp., and Herbert Schlickenmaier, comp. (Federal Aviation Administration, Washington, DC.) Jan. 1991 490 p Conference held in Hampton, VA, 16-18 Oct. 1990 Prepared in cooperation with FAA, Washington, DC
(NASA-CP-10060-Pt-1; NAS 1.55:10060-Pt-1; DOT/FAA/RD-91/2-Pt-1) Avail: NTIS HC/MF A21 CSCL 14B

Papers presented at the conference on airborne wind shear detection and warning systems are compiled. The following subject areas are covered: terms of reference; case study; flight management; sensor fusion and flight evaluation; Terminal Doppler Weather Radar data link/display; heavy rain aerodynamics; and second generation reactive systems. For individual titles, see N91-24167 through N91-24184.

N91-24167*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
LIDAR STUDIES ON MICROBURSTS
Y. Aurenche and J. L. Boulay *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 29-35 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 14B

Preliminary analysis of requirements for future airborne windshear detection systems is presented. The following topics are covered: flight mechanics; microbursts modeling; microburst detection with airborne systems (LIDAR, radar, passive IR sensors); microbursts prediction with ground systems (VHF interferometry). A short overview of these studies is presented and some results are discussed. Author

N91-24168*# Service Technique de la Navigation Aerienne, Paris (France).
RADAR PERFORMANCE EXPERIMENTS
C. LeRoux, F. Bertin, and H. Mounir (Centre National d'Etudes des Telecommunications, Saint Maur des Fosses, France) *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 37-54 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 14B

Theoretical studies and experimental results obtained at Coulommiers airport showed the capability of Proust radar to detect wind shears, in clear air condition as well as in presence of clouds or rain. Several examples are presented: in a blocking highs situation an atmospheric wave system at the Brunt-Vaisala frequency can be clearly distinguished; in a situation of clouds without rain the limit between clear air and clouds can be easily seen; and a windshear associated with a gust front in rainy conditions is shown. A comparison of 30 cm clear air radar Proust and 5 cm weather Doppler radar Ronsard will allow to select the best candidate for wind shear detection, taking into account the low sensibility to ground clutter of Ronsard radar. Author

N91-24169*# Remtech, S.A., Paris (France).
MEGASODAR EXPERIMENT
Alain Donzier *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 57-59 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 14B

SODAR application to wind shear and wake vortex detection is described. A commercial phase array SODAR line was developed and operated at Roissy International Airport for a few days. Some radial wind data are presented. Even though this system was not optimized for such application, it showed ranges of about 800 m for an averaging time of 10 min and an elevation angle of 20 deg. Some strong echo regions are present in the data and seem to be related to wake vortex. Author

N91-24170*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATED DATA ANALYSIS OF JULY 7, 1990 MICROBURST **c47**
Dave Hinton *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 63-79 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 04B

Integrated data analysis of July 7, 1990 microburst is presented in the form of view-graphs. Topics included are: summer 1990

TDWR flight experiment; least square estimate of linear shear; event synopsis; TDWR (terminal Doppler weather radar) data analysis; citation aircraft in situ data analysis; infrared data analysis; and summary of July 7 event. Author

N91-24171*# Mesoscale Environmental Simulations and Operations, Inc., Hampton, VA.
MODEL COMPARISON OF JULY 7, 1990 MICROBURST c47
Fred Proctor *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 81-103 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 04B

Model comparison of July 7, 1990 microburst is presented in the form of view-graphs. The following topics are covered: 7 July 1990 Orlando, FL simulations; model input sounding for 7 July 1990 Orlando case; 7 July 1990 Orlando microburst; and comparison of simulated and observed characteristics of microburst event. Author

N91-24172*# Massachusetts Inst. of Tech., Cambridge.
MICROBURST AVOIDANCE SIMULATION TESTS
John Hansman *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 107-141 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

Implementation issues for uplinked microburst alerts are presented in the form of view-graphs. The following topics are covered: evaluation, transmission, and presentation of ground-based Doppler weather radar derived information through a limited bandwidth digital data link; electronic cockpit presentation of uplinked wind shear alerts (pilot opinion survey, part-task simulation experiment); presentation modes (verbal, textual, and graphical); and ground evaluation of ground-measures wind shear data. Author

N91-24173*# Flight Safety Foundation, Inc., Arlington, VA.
WIND SHEAR TRAINING APPLICATIONS FOR 91/135
Ed Arbon *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 143-152 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

The requirement for wind shear training af all pilots was demonstrated too often by the accident statistics of past years. Documents were developed to train airline crews on the specific aircraft and to tech recognition of the meteorological conditions that are conductive to wind shear and microburst formation. A Wind Shear Training Aid program is discussed. Author

N91-24174*# Honeywell, Inc., Phoenix, AZ. Commercial Flight Systems Group.
INTEGRATION OF WEATHER SENSING DEVICES
Jim Daily *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 177-199 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

The state of airborne atmospheric sensing is continually evolving as devices are developed which further enhance the detection of meteorological phenomena. Assuming that these technologies prove to be feasible, the greatest long-term benefit would be attained by effective integration of the various sensors. A system which could accomplish this goal would conceivably provide enhanced atmospheric analysis, coherent display capability, and would allow for the development of expert system to predict weather conditions. The existing and developing weather detection technologies are presented, followed by an overview of what issues must be dealt with in the creation of an integrated system. A framework of a basic system is also presented which identifies some of the potential applications that exist. Author

N91-24175*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA LANGLEY FLIGHT TEST PROGRAM
Mike Lewis *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 201-224 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

General overview of NASA/Langley Research Center wind shear flight project is presented in the form of view-graphs. The following subject areas are covered: program elements (hazard characterization, sensor technology, and flight management systems); flight test objective; facility; flight requirements; flight operations; and status/schedule. Author

N91-24176*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TDWR INFORMATION ON THE FLIGHT DECK
Dave Hinton *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 227-242 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

TDWR information on the flight deck is presented in the form of view-graphs. The following subject areas are covered: air/ground wind shear information integration research; wind shear detection/warning and avoidance system; initial experiment; and future plans. Author

N91-24177*# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
ORLANDO EXPERIMENT
Steve Campbell *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 243-262 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

FAA terminal Doppler weather radar program and NASA/FAA airborne wind shear program are presented in the form of view-graphs. The following topics are included: TDWR testbed radar performance; cockpit display system; flight operations; analysis workstation; and future work. Author

N91-24178*# National Center for Atmospheric Research, Boulder, CO.
INTEGRATION OF THE TDWR AND LLWAS WIND SHEAR DETECTION SYSTEM
Larry Cornman *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 263-297 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

Operational demonstrations of a prototype TDWR/LLWAS (Terminal Doppler Weather Radar/Low Level Wind shear Alarm System) integrated wind shear detection system were conducted. The integration of wind shear detection systems is needed to provide end-users with a single, consensus source of information. A properly implemented integrated system provides wind shear warnings of a higher quality than stand-alone LLWAS or TDWR systems. The algorithmic concept used to generate the TDWR/LLWAS integrated products and several case studies are discussed, indicating the viability and potential of integrated wind shear detection systems. Implications for integrating ground and airborne wind shear detection systems are briefly examined. Author

N91-24179*# Mitre Corp., McLean, VA.
THERMODYNAMIC ALERTER FOR MICROBURSTS (TAMP)
Peter J. Eccles *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 351-363 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

The following subject areas are covered: microburst detection, location and measurement; thermal alerter for microbursts prototypes (TAMP); sensor-transmitters (Senstrans) design; TAMP installation; and DAPAD software. Author

N91-24180*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STATUS OF HEAVY RAIN TESTS
Gaudy Bezos *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 367-393 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

The heavy rain effects program is presented in the form of the view-graphs. The following topics are covered: rain effects on airfoil performance; two-phase flow dynamics; wind tunnel test results; issues; large-scale results; and summary. Author

N91-24181*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
HEAVY RAIN FIELD MEASUREMENTS
Ed Melson *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 395-424 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

A weight-measuring rain gauge was developed to collect rain data and configured to operate at a high sample rate (one sample pre second). Instead of averaging the rain rate in minutes, hours, and sometime days as normally performed, the rain data collected are examined in seconds. The results of six field sites are compiled. Rain rate levels, duration of downpours, and frequency of heavy rainfall events are presented. Author

N91-24182*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ESTIMATE OF HEAVY RAIN PERFORMANCE EFFECT
Dan D. Vicroy *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 425-450 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

The aerodynamic effect of heavy rain on airplane performance is presented in the form of view-graphs. The following subject areas are covered: review of heavy rain airfoil tests; development of heavy rain aerodynamic model for a twin-jet transport; performance analysis with heavy rain effects; numeric simulation of wet microburst encounter; and summary of results and future needs. Author

N91-24183*# Sundstrand Data Control, Inc., Redmond, WA.
STATUS OF SUNDSTRAND RESEARCH
Don Bateman *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 453-477 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

Wind shear detection status is presented in the form of view-graphs. The following subject areas are covered: second generation detection (Q-bias, gamma bias, temperature biases, maneuvering flight modulation, and altitude modulation); third generation wind shear detection (use wind shear computation to augment flight path and terrain alerts, modulation of alert thresholds based on wind/terrain data base, incorporate wind shear/terrain alert enhancements from predictive sensor data); and future research and development. Author

N91-24184*# Honeywell, Inc., Phoenix, AZ. Commercial Flight Systems Div.
TEMPERATURE LAPSE RATE AS AN ADJUNCT TO WIND SHEAR DETECTION
Terry Zweifil *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 479-495 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 01C

Several meteorological parameters were examined to determine if measurable atmospheric conditions can improve windshear detection devices. Lapse rate, the temperature change with altitude, shows promise as being an important parameter in the prediction of severe wind shears. It is easily measured from existing aircraft instrumentation, and it can be important indicator of convective activity including thunderstorms and microbursts. The meteorological theory behind lapse rate measurement is briefly reviewed, and and FAA certified system is described that is currently implemented in the Honeywell Wind Shear Detection and Guidance System. Author

N91-24185# Computer Resource Management, Inc., Herndon, VA.
NATIONAL AIRSPACE SYSTEM. COMMUNICATIONS OPERATIONAL CONCEPT NAS-SR-136
William Trent, Thomas Pickerell, and Harold Nelson May 1991 68 p
(Contract DTFA01-91-Y-01004)
(DOT/FAA/SE-91/1) Avail: NTIS HC/MF A04

A requirement of the National Airspace System (NAS) is to provide for communications, as identified in the NAS Requirement Specification, NAS-SR-1000 (NASSRS). A concept of operation for air-ground, ground-ground communications connectivity and capability, and national emergency communications is presented. This concept describes the capabilities and shows the relationships between subsystems, facilities, information, and operators/users. It is intended to provide a common perspective for personnel involved in communication activities, assist in determining whether communications meet formal requirements, and support coordination among the organizations involved. This concept is one of eight operational concepts. The remaining yet to be written concepts will complete the description of the system requirements as detailed in the NASSRS. Author

N91-24186# Royal Aerospace Establishment, Farnborough (England).
LIGHTNING PROTECTION REQUIREMENTS FOR AIRCRAFT: A PROPOSED SPECIFICATION
G. A. M. Odam, A. W. Hanson, and R. H. Evans (Halarose Ltd., England) 25 Oct. 1990 147 p Revised
(RAE-TM-FS(F)-632-Issue-1-Rev; BR116373; ETN-91-99331)
Copyright Avail: NTIS HC/MF A07

A Royal Aerospace recommendation for a specification to define the United Kingdom Ministry of Defense (UK MOD) requirements for the lightning protection of aircraft is presented. It is an appendix to a JAC paper proposing changes to the lightning content of DEF STAN 00-970. This issue covers background and advisory material, certification, design, and testing requirements. It applies to all fixed and rotary wing aircraft. ESA

N91-24187# Army Aeromedical Research Lab., Fort Rucker, AL.
THE AIRBAG AS A SUPPLEMENT TO STANDARD RESTRAINT SYSTEMS IN THE AH-1 AND AH-64 ATTACK HELICOPTERS AND ITS ROLE IN REDUCING HEAD STRIKES OF THE COPILOT/GUNNER, VOLUME 2 Final Report
Nabih M. Alem, Dennis F. Shanahan, and John V. Barson Jan.

1991 162 p
(AD-A232907; USAARL-91-6-Vol-2) Avail: NTIS HC/MF A08 CSCL 01/3

Accident investigation records of U.S. Army helicopter crashes show injuries of pilots due to striking a structure inside the cockpit outnumber those due to excessive accelerations by a five-to-one ratio. This two-volume report presents the results of a study of the effectiveness of airbags in reducing the severity of contact injury to the gunner when striking the gunsight. Airbag systems were installed on the gunsights in simulated Cobra and Apache cockpits, then sled tested at 7 and 25 g. The tests indicated airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head angular acceleration by 76 percent in the Cobra tests. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 percent. An airbag system, the report concludes, is likely to prevent severe or fatal head and chest injuries in an Apache or Cobra crash. Volume 1 of the report describes the tests and discusses the results. Volume 2 consists of Appendixes A, B, and C of the report and contains processed signal graphs of all sled tests. GRA

N91-24188# Army Aeromedical Research Lab., Fort Rucker, AL.
THE AIRBAG AS A SUPPLEMENT TO STANDARD RESTRAINT SYSTEMS IN THE AH-1 AND AH-64 ATTACK HELICOPTERS AND ITS ROLE IN REDUCING HEAD STRIKES OF THE COPILOT/GUNNER, VOLUME 1 Final Report
Nabih M. Alem, Dennis F. Shanahan, John V. Barson, and William H. Muzzy, III Jan. 1991 50 p
(DA Proj. 3M1-62787-A-878)
(AD-A233349; USAARL-91-6-Vol-1) Avail: NTIS HC/MF A03 CSCL 01/3

Accident investigation records of U.S. Army helicopter crashes show injuries of pilots due to striking a structure inside the cockpit outnumber those due to excessive accelerations by a five-to-one ratio. This two-volume reports presents the results of a study of the effectiveness of airbags in reducing the severity of contact injury to the gunner when striking the gunsight. Airbag systems were installed on the gunsights in simulated Cobra and Apache cockpits, then sled tested at 7 and 25 g. The tests indicated airbags reduced head accelerations by 65 pct. head injury criteria by 77 pct. and head angular acceleration by 76 pct. in the Cobra tests. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 pct. It is concluded that an airbag system works very well. Volume 1 of the report describes the tests and discusses the results. GRA

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

N91-24189# Federal Aviation Administration, Washington, DC.
AVIATION SYSTEM CAPITAL INVESTMENT PLAN Annual Report
Dec. 1990 355 p
(PB91-150268) Avail: NTIS HC/MF A16 CSCL 17G

The plan describes the policies and strategies that the FAA will pursue in addressing key concerns of the National Airspace System (NAS). The plan addresses safety, efficiency, traffic demands, aging equipment and facilities, and airspace use. The Capital Investment Plan (CIP) was developed to prepare the NAS for new developments. The plan makes the approach to air traffic modernization more precise, flexible, understandable, and dynamic. It distinguishes among near-term (1991-1995), mid-term (1996-2000), and far-term (2001-2005) planning. GRA

N91-24190# Federal Aviation Administration, Atlantic City, NJ.
MLS MATHEMATICAL MODEL VALIDATION STUDY USING AIRBORNE MLS DATA FROM ATLANTIC CITY INTERNATIONAL AIRPORT BOEING 727 ELEVATION SHADOWING FLIGHT TESTS Technical Report, Dec. 1988 - Dec. 1990
Jesse D. Jones Apr. 1991 49 p
(DOT-FAA/CT-TN90/55) Avail: NTIS HC/MF A03

The performance of the Microwave Landing System (MLS) mathematical model is evaluated by comparing the results of the model's simulation errors along a flight path with actual flight check measurements. The data collected for this study were designed specifically to evaluate the shadowing aircraft computations of the model. The results showed that there was some agreement between measured and modeled data, but it was concluded that further development of the shadowing aircraft computations is required. Author

N91-24191# Visicom Labs., Inc., San Diego, CA.
WESTERN PACIFIC OMEGA VALIDATION ANALYSIS Final Report, Aug. 1989 - Aug. 1990
Verne E. Hildebrand Aug. 1990 303 p
(Contract N00123-86-D-0134)
(AD-A232457; USCG-ONSCEN-03-90) Avail: NTIS HC/MF A14 CSCL 17/7

This report, the seventh in the Omega Validation series assesses the Omega Very Low Frequency radio navigation system performance in the Western Pacific Ocean area. Our general overview describes: (1) a new emphasis for this validations on establishing signal quality through characterizing zones of signal-self-interference, (2) validation planning, (3) measurements, and (4) analysis undertaken. Regions of self-interference due to equatorial zone propagation are predicted and analyzed for each Omega signal. Zones of poor signal interference caused by propagation the long way around the world (long-path) are predicted and assessed. Navigation accuracy and signal coverage is assessed. For most of the validation region Omega fully meets navigation expectations. The prediction guidance in the form of Propagation Phase Corrections, zones of poor signal quality (Modal and Long-path), and Station Coverage are largely correct. A relatively small but highly significant zone of predicted inadequate coverage during certain periods of the day was identified and assessed. Navigation support in this zone, which extends approximately between latitude 20 deg N and 5 deg S and between longitude 105 deg E and 120 deg E, was found to be unreliable at night during periods of strong atmospheric noise. GRA

N91-24192 Department of the Navy, Washington, DC.
SEMI-AUTOMATIC DIRECTION FINDING Patent
William P. Huntley, inventor (to Navy) and David J. Swanick, inventor (to Navy) 8 Jan. 1991 6 p Filed 5 Dec. 1989
(AD-D014834; US-Patent-4,983,983; US-Patent-Appl-SN-446262; US-Patent-Class-342-443) Avail: US Patent and Trademark Office CSCL 17/3

A receiver selects and amplitude demodulates an RF signal from one of a plurality of directional antennas. The demodulated signal is then delayed to put it in time synchronism with the same signal information from an omnidirectional antenna. A signal is then generated of the peak pulses of the demodulated signal when the pulses are in time synchronism with pulses from the omnidirectional antenna. A control indicator receives the peak pulses along with periscope bearing signals and ship's heading signals and gives an r, display of the amplitude of the RF signal selected from the directional antenna at the periscope true bearing angle. GRA

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.For land transportation vehicles see *85 Urban Technology and Transportation.*

N91-24193*# Sparta, Inc., Laguna Hills, CA.
HYPERSONIC RESEARCH VEHICLE (HRV) REAL-TIME FLIGHT TEST SUPPORT FEASIBILITY AND REQUIREMENTS STUDY. PART 1: REAL-TIME FLIGHT EXPERIMENT SUPPORT
Herman A. Rediess, Rudrapatna V. Ramnath, Daniel L. Vrable, David H. Hirvo, Lowell D. McMillen, and Irving B. Osofsky May 1991 36 p
(Contract NAS2-12670)
(NASA-CR-179449; H-1677-Pt-1; NAS 1.26:179449) Avail: NTIS HC/MF A03 CSCL 01C

The results are presented of a study to identify potential real time remote computational applications to support monitoring HRV flight test experiments along with definitions of preliminary requirements. A major expansion of the support capability available at Ames-Dryden was considered. The focus is on the use of extensive computation and data bases together with real time flight data to generate and present high level information to those monitoring the flight. Six examples were considered: (1) boundary layer transition location; (2) shock wave position estimation; (3) performance estimation; (4) surface temperature estimation; (5) critical structural stress estimation; and (6) stability estimation. Author

N91-24194*# Sparta, Inc., Laguna Hills, CA.
HYPERSONIC RESEARCH VEHICLE (HRV) REAL-TIME FLIGHT TEST SUPPORT FEASIBILITY AND REQUIREMENTS STUDY. PART 2: REMOTE COMPUTATION SUPPORT FOR FLIGHT SYSTEMS FUNCTIONS
Herman A. Rediess and M. D. Hewett May 1991 42 p
(Contract NAS2-12670)
(NASA-CR-179450; H-1700-pt-2; NAS 1.26:179450) Avail: NTIS HC/MF A03 CSCL 01C

The requirements are assessed for the use of remote computation to support HRV flight testing. First, remote computational requirements were developed to support functions that will eventually be performed onboard operational vehicles of this type. These functions which either cannot be performed onboard in the time frame of initial HRV flight test programs because the technology of airborne computers will not be sufficiently advanced to support the computational loads required, or it is not desirable to perform the functions onboard in the flight test program for other reasons. Second, remote computational support either required or highly desirable to conduct flight testing itself was addressed. The use is proposed of an Automated Flight Management System which is described in conceptual detail. Third, autonomous operations is discussed and finally, unmanned operations. Author

N91-24195*# Douglas Aircraft Co., Inc., Long Beach, CA.
THE 1989 HIGH-SPEED CIVIL TRANSPORT STUDIES
Washington NASA May 1991 103 p
(Contract NAS1-18378)
(NASA-CR-4375; NAS 1.26:4375) Avail: NTIS HC/MF A06 CSCL 01C

The results are presented for the Douglas Aircraft Company system studies related to high speed civil transports (HSCTs). The system studies were conducted to assess the environmental compatibility of a HSCT at a design Mach number of 3.2. Sonic boom minimization, exterior noise, and engine emissions were assessed together with the effect of a laminar flow control (LFC) technology on vehicle gross weight. The general results indicated that (1) achievement of a 90 PLdB sonic boom loudness level goal at Mach 3.2 may not be practical; (2) the high flow engine cycle concept shows promise of achieving the side line FAR Part 36 noise limit but may not achieve the aircraft range design goal of 6,500 nautical miles; (3) the rich burn/quick quench (RB/QQ) combustor concept shows promise for achieving low EINO(sub x) levels when combined with a premixed pilot stage/advanced technology high power stage duct burner in the P and W variable stream control engine (VSCE); and (4) full chord wing LFC has significant performance and economic advantages relative to the turbulent wing baseline. Author

N91-24196*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SYSTEM APPROACH TO AIRCRAFT OPTIMIZATION
Jaroslaw Sobieszczanski-Sobieski Mar. 1991 17 p Presented at the NATO-AGARD Structures and Materials Panel Meeting, Bath, England, 28 Apr. - 5 May 1991
(NASA-TM-104074; NAS 1.15:104074) Avail: NTIS HC/MF A03 CSCL 01C

Mutual couplings among the mathematical models of physical phenomena and parts of a system such as an aircraft complicate the design process because each contemplated design change may have a far reaching consequence throughout the system. Techniques are outlined for computing these influences as system design derivatives useful for both judgemental and formal optimization purposes. The techniques facilitate decomposition of the design process into smaller, more manageable tasks and they form a methodology that can easily fit into existing engineering organizations and incorporate their design tools. Author

N91-24197# Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
THE EFFECTS ON AERODYNAMIC PERFORMANCE OF DESIGNING SUPERSONIC WINGS FOR LAMINAR FLOW CONTROL Interim Report
Carl P. Tilmann 30 Jan. 1991 90 p
(AD-A233040; WL-TM-91-303) Avail: NTIS HC/MF A05 CSCL 01/1

A preliminary technique has been developed for the design of wings to be used with supersonic hybrid method laminar flow control systems. This technique has been used to evaluate the effects on aerodynamic performance of designing supersonic wings for laminar flow control. In this design method, a wing is cambered such that it produces and upper-surface streamwise pressure distribution which is favorable for use in a hybrid laminar flow control (HLFC) system, while maintaining a spanwise lifting distribution which will minimize drag-due-to-lift. An existing linear-theory computer program is used to calculate the wing camber definition that produces a desired pressure distribution on the upper surface of the wing with a specified thickness profile. This method was applied to an array of arrow-wings varying in aspect ratio and taper ratio. Each wing planform was then camber-optimized for minimum cruise drag-due-to-lift using current preliminary wing design methods, which optimize the wing's camber of lifting load distribution without regard to the boundary layer type. The total drag of each wing is then estimated by the superposition of zero-lift wave drag, skin friction drag, and drag-due-to-lift. The true effectiveness of laminar flow control wings could then be evaluated by weighing the benefit of the reduced friction drag against the penalty of increased drag-due-to-lift which would be displayed by a wing designed for a laminar flow control system. GRA

N91-24198*# Advanced Technologies, Inc., Newport News, VA.
SOFT HUB FOR BEARINGLESS ROTORS
Peter G. C. Dixon Jun. 1991 98 p
(Contract NAS2-13157)
(NASA-CR-177586; A-91158; NAS 1.26:177586) Avail: NTIS HC/MF A05 CSCL 01C

Soft hub concepts which allow the direct replacement of articulated rotor systems by bearingless types without any change in controllability or need for reinforcement to the drive shaft and/or transmission/fuselage attachments of the helicopter were studied. Two concepts were analyzed and confirmed for functional and structural feasibility against a design criteria and specifications

established for this effort. Both systems are gimballed about a thrust carrying universal elastomeric bearing. One concept includes a set of composite flexures for drive torque transmittal from the shaft to the rotor, and another set (which is changeable) to impart hub tilting stiffness to the rotor system as required to meet the helicopter application. The second concept uses a composite bellows flexure to drive the rotor and to augment the hub stiffness provided by the elastomeric bearing. Each concept was assessed for weight, drag, ROM cost, and number of parts and compared with the production BO-105 hub. Author

N91-24199*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EVALUATION OF CLOUD DETECTION INSTRUMENTS AND PERFORMANCE OF LAMINAR-FLOW LEADING-EDGE TEST ARTICLES DURING NASA LEADING-EDGE FLIGHT-TEST PROGRAM
Richard E. Davis, Dal V. Maddalon, Richard D. Wagner, David F. Fisher, and Ronald Young (National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.) Apr. 1989 58 p
(NASA-TP-2888; L-16509; NAS 1.60:2888) Avail: NTIS HC/MF A04 CSCL 01C

Summary evaluations of the performance of laminar-flow control (LFC) leading edge test articles on a NASA JetStar aircraft are presented. Statistics, presented for the test articles' performance in haze and cloud situations, as well as in clear air, show a significant effect of cloud particle concentrations on the extent of laminar flow. The cloud particle environment was monitored by two instruments, a cloud particle spectrometer (Knollenberg probe) and a charging patch. Both instruments are evaluated as diagnostic aids for avoiding laminar-flow detrimental particle concentrations in future LFC aircraft operations. The data base covers 19 flights in the simulated airline service phase of the NASA Leading-Edge Flight-Test (LEFT) Program. Author

N91-24200*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA-LaRc FLIGHT-CRITICAL DIGITAL SYSTEMS TECHNOLOGY WORKSHOP
C. W. Meissner, Jr., ed., J. R. Dunham, ed., and G. Crim, ed. Apr. 1989 191 p Workshop held in Hampton, VA, 13-15 Dec. 1988
(NASA-CP-10028; Rept-412U-3181-29; NAS 1.55:10028) Avail: NTIS HC/MF A09 CSCL 01C

The outcome is documented of a Flight-Critical Digital Systems Technology Workshop held at NASA-Langley December 13 to 15 1988. The purpose of the workshop was to elicit the aerospace industry's view of the issues which must be addressed for the practical realization of flight-critical digital systems. The workshop was divided into three parts: an overview session; three half-day meetings of seven working groups addressing aeronautical and space requirements, system design for validation, failure modes, system modeling, reliable software, and flight test; and a half-day summary of the research issues presented by the working group chairmen. Issues that generated the most consensus across the workshop were: (1) the lack of effective design and validation methods with support tools to enable engineering of highly-integrated, flight-critical digital systems, and (2) the lack of high quality laboratory and field data on system failures especially due to electromagnetic environment (EME). Author

N91-24137*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL SUPPORT OF THE X-29A ADVANCED TECHNOLOGY DEMONSTRATOR FLIGHT EXPERIMENT
E. G. Waggoner and B. L. Bates (Vigyan Research Associates, Inc., Hampton, VA.) *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 147-166 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 01C

N91-24138*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RESULTS OF CORRELATIONS FOR TRANSITION LOCATION ON A CLEAN-UP GLOVE INSTALLED ON AN F-14 AIRCRAFT AND DESIGN STUDIES FOR A LAMINAR GLOVE FOR THE X-29 AIRCRAFT ACCOUNTING FOR SPANWISE PRESSURE GRADIENT
S. H. Goradia (Vigyan Research Associates, Inc., Hampton, VA.), P. J. Bobbitt, H. L. Morgan, J. C. Ferris, and William D. Harvey *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 167-227 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 01A

N91-24158# Wichita State Univ., KS.
FEASIBILITY STUDY IN CRACK DETECTION IN AIRCRAFT STIFFENED PANELS BY PULSE PROBING AND DECONVOLUTION
Jorge E. Talia, Behnam Bahr, and Hamid M. Lankarani *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

N91-24286*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COOLING SYSTEM AND INSULATION CONCEPT FOR A MACH 5 TURBO-RAMJET AIRCRAFT
S. C. Jones (Lockheed Engineering and Sciences Co., Hampton, VA.) and D. H. Petley *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 191-201 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20 CSCL 01C

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

N91-24201*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STATIC PERFORMANCE TESTS OF A FLIGHT-TYPE STOVL EJECTOR
Wendy S. Barankiewicz 1991 12 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; cosponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104437; E-6131; NAS 1.15:104437; AIAA-91-1902)
Avail: NTIS HC/MF A03 CSCL 21E

The design and development of thrust augmenting STOVL ejectors has typically been based on experimental iteration (i.e., trial and error). Static performance tests of a full scale vertical lift ejector were performed at primary flow temperatures up to 1560 R (1100 F). Flow visualization (smoke generators and yarn tufts) were used to view the inlet air flow, especially around the primary

nozzle and end plates. Performance calculations are presented for ambient temperatures close to 480 R (20 F) and 535 R (75 F) which simulate seasonal aircraft operating conditions. Resulting thrust augmentation ratios are presented as functions of nozzle pressure ratio and temperature. Author

N91-24202*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MIXING OF MULTIPLE JETS WITH A CONFINED SUBSONIC CROSSFLOW. SUMMARY OF NASA-SUPPORTED EXPERIMENTS AND MODELING
James D. Holdeman 1991 49 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME and the American Socienty for Electrical Engineers
(NASA-TM-104412; E-6239; NAS 1.15:104412; AIAA-91-2458)
Avail: NTIS HC/MF A03 CSCL 21E

Experimental and computational results on the mixing of single, double, and opposed rows of jets with an isothermal or variable temperature mainstream in a confined subsonic crossflow are summarized. The studies were performed to investigate flow and geometric variations typical of the complex 3-D flowfield in the dilution zone of combustion chambers in gas turbine engines. The principal observations from the experiments were that the momentum-flux ratio was the most significant flow variable, and that temperature distributions were similar (independent of orifice diameter) when the orifice spacing and the square-root of the momentum-flux ratio were inversely proportional. The experiments and empirical model for the mixing of a single row of jets from round holes were extended to include several variations typical of gas turbine combustors. Combinations of flow and geometry that gave optimum mixing were identified from the experimental results. Based on results of calculations made with a 3-D numerical model, the empirical model was further extended to model the effects of curvature and convergence. The principle conclusions from this study were that the orifice spacing and momentum-flux relationships were the same as observed previously in a straight duct, but the jet structure was significantly different for jets injected from the inner wall wall of a turn than for those injected from the outer wall. Also, curvature in the axial direction caused a drift of the jet trajectories toward the inner wall, but the mixing in a turning and converging channel did not seem to be inhibited by the convergence, independent of whether the convergence was radial or circumferential. The calculated jet penetration and mixing in an annulus were similar to those in a rectangular duct when the orifice spacing was specified at the radius dividing the annulus into equal areas. Author

N91-24203*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FUEL-RICH, CATALYTIC REACTION EXPERIMENTAL RESULTS
R. James Rollbuhler 1991 23 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104423; E-6256; NAS 1.15:104423; AIAA-91-2463)
Avail: NTIS HC/MF A03 CSCL 21E

Future aeropropulsion gas turbine combustion requirements call for operating at very high inlet temperatures, pressures, and large temperature rises. At the same time, the combustion process is to have minimum pollution effects on the environment. Aircraft gas turbine engines utilize liquid hydrocarbon fuels which are difficult to uniformly atomize and mix with combustion air. An approach for minimizing fuel related problems is to transform the liquid fuel into gaseous form prior to the completion of the combustion process. Experimentally obtained results are presented for vaporizing and partially oxidizing a liquid hydrocarbon fuel into burnable gaseous components. The presented experimental data show that 1200 to 1300 K reaction product gas, rich in hydrogen, carbon monoxide, and light-end hydrocarbons, is formed when flowing 0.3 to 0.6 fuel to air mixes through a catalyst reactor. The reaction temperatures are kept low enough that nitrogen oxides and carbon particles (soot) do not form. Results are reported for tests using different catalyst types and configurations, mass flowrates, input temperatures, and fuel to air ratios. Author

N91-24204*# Avco Lycoming Div., Stratford, CT.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) STUDY. PROGRAM REPORT Final Report
E. Almodovar, T. Exley, H. Kaehler, and W. Schneider Mar. 1986 161 p
(Contract NAS3-24545; DA Proj. 1L1-61101-AH-45)
(NASA-CR-175077; LYC-86-11; NAS 1.26:175077; AVSCOM-TR-86-C-12) Avail: NTIS HC/MF A08 CSCL 21E

The study was conducted to identify high payoff technologies for year 2000 small gas turbine applications and to provide a technology plan for guiding future research and technology efforts. A regenerative cycle turboprop engine was selected for a 19 passenger commuter aircraft application. A series of engines incorporating eight levels of advanced technologies were studied and their impact on aircraft performance was evaluated. The study indicated a potential reduction in fuel burn of 38.3 percent. At $1.00 per gallon fuel price, a potential DOC benefit of 12.5 percent would be achieved. At $2.00 per gallon, the potential DOC benefit would increase to 17.0 percent. Four advanced technologies are recommended and appropriate research and technology programs were established to reach the year 2000 goals. Author

N91-24205*# Garrett Turbine Engine Co., Phoenix, AZ.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) Final Report
M. Early, R. Dawson, P. Zeiner, M. Turk, and K. Benn Mar. 1986 470 p
(Contract NAS3-24544; DA Proj. 1L1-61101-AH-45)
(NASA-CR-175078; NAS 1.26:175078; AVSCOM-TR-86-C-11; GARRETT-21-5776-2A) Avail: NTIS HC/MF A20 CSCL 21E

A study of small gas turbine engines was conducted to identify high payoff technologies for year-2000 engines and to define companion technology plans. The study addressed engines in the 186 to 746 KW (250 to 1000 shp) or equivalent thrust range for rotorcraft, commuter (turboprop), cruise missile (turbojet), and APU applications. The results show that aggressive advancement of high payoff technologies can produce significant benefits, including reduced SFC, weight, and cost for year-2000 engines. Mission studies for these engines show potential fuel burn reductions of 22 to 71 percent. These engine benefits translate into reductions in rotorcraft and commuter aircraft direct operating costs (DOC) of 7 to 11 percent, and in APU-related DOCs of 37 to 47 percent. The study further shows that cruise missile range can be increased by as much as 200 percent (320 percent with slurry fuels) for a year-2000 missile-turbojet system compared to a current rocket-powered system. The high payoff technologies were identified and the benefits quantified. Based on this, technology plans were defined for each of the four engine applications as recommended guidelines for further NASA research and technology efforts to establish technological readiness for the year 2000.
Author

N91-24206*# Williams International, Walled Lake, MI.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) STUDIES Final Report
P. K. Meyer and L. Harbour Mar. 1986 139 p
(Contract NAS3-24543; DA Proj. 1L1-61101-AH-45)
(NASA-CR-175080; NAS 1.26:175080; AVSCOM-TR-86-C-9; FSCM-24235; Rept-074-021-M-005) Avail: NTIS HC/MF A07 CSCL 21E

A study was conducted to identify component technology requirements for small, expendable gas turbine engines that would result in substantial improvements in performance and cost by the year 2000. A subsonic, 2600 nautical mile (4815 km) strategic cruise missile mission was selected for study. A baseline (state-of-the-art) engine and missile configuration were defined to evaluate the advanced technology engines. Two advanced technology engines were configured and evaluated using advanced component efficiencies and ceramic composite materials; a 22:1

overall pressure ratio, 3.85 bypass ratio twin-spool turbofan; and an 8:1 overall pressure, 3.66 bypass ratio, single-spool recuperated turbofan with 0.85 recuperator effectiveness. Results of mission analysis indicated a reduction in fuel burn of 38 and 47 percent compared to the baseline engine when using the advanced turbofan and recuperated turbofan, respectively. While use of either advanced engine resulted in approximately a 25 percent reduction in missile size, the unit life cycle (LCC) cost reduction of 56 percent for the advanced turbofan relative to the baseline engine gave it a decisive advantage over the recuperated turbofan with 47 percent LCC reduction. An additional range improvement of 10 percent results when using a 56 percent loaded carbon slurry fuel with either engine. These results can be realized only if significant progress is attained in the fields of solid lubricated bearings, small aerodynamic component performance, composite ceramic materials and integration of slurry fuels. A technology plan outlining prospective programs in these fields is presented. Author

N91-24207*# General Motors Corp., Indianapolis, IN. Allison Gas Turbine Div.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) STUDY Final Report
T. R. Larkin Mar. 1986 156 p
(Contract NAS3-24542; DA Proj. 1L1-61101-AH-45)
(NASA-CR-175081; EDR-12422; NAS 1.26:175081; AVSCOM-TR-86-C-8) Avail: NTIS HC/MF A08 CSCL 21E

The objective of this study is to identify high payoff technologies for year 2000 small gas turbine engines, and to provide a technology plan to guide research and technology efforts toward revolutionizing the small gas turbine technology base. The goal is to define the required technology to provide a 30 percent reduction in mission fuel burned, to reduce direct operating costs by at least 10 percent, and to provide increased reliability and durability of the gas turbine propulsion system. The baseline established to evaluate the year 2000 technology base was an 8-passenger commercial tilt-rotor aircraft powered by a current technology gas turbine engine. Three basic engine cycles were studied: the simple cycle engine, a waste heat recovery cycle, and a wave rotor engine cycle. For the simple cycle engine, two general arrangements were considered: the traditional concentric spool arrangement and a nonconcentric spool arrangement. Both a regenerative and a recuperative cycle were studied for the waste heat recovery cycle. Author

N91-24208*# Teledyne CAE, Toledo, OH.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) STUDY Final Report
B. Singh Mar. 1986 102 p Prepared for Army Aviation Systems Command, Cleveland, OH
(Contract NAS3-24541; DA Proj. 1L1-61101-AH-45)
(NASA-CR-175079; NAS 1.26:175079; AVSCOM-TR-86-C-10; TELEDYNE-CAE-2224) Avail: NTIS HC/MF A06 CSCL 21E

Small advanced (450 to 850 pounds thrust, 2002 to 3781 N) gas turbine engines were studied for a subsonic strategic cruise missile application, using projected year 2000 technology. An aircraft, mission characteristics, and baseline (state-of-the-art) engine were defined to evaluate technology benefits. Engine performance and configuration analyses were performed for two and three spool turbofan and propfan engine concepts. Mission and Life Cycle Cost (LCC) analyses were performed in which the candidate engines were compared to the baseline engines over a prescribed mission. The advanced technology engines reduced system LCC up to 41 percent relative to the baseline engine. Critical aerodynamic, materials, and mechanical systems turbine engine technologies were identified and program plans were defined for each identified critical technology. Author

N91-24292# Teledyne CAE, Toledo, OH.
MODEL 320-2: A COMPACT ADVANCED UAV TURBOJET
Eli H. Benstein, Brian Cassem, and Kathy Elliott *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 285-294 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

N91-24209*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SIMULATION EVALUATION OF A SPEED-GUIDANCE LAW FOR HARRIER APPROACH TRANSITIONS
Vernon K. Merrick, Ernesto Moralez, Michael W. Stortz, Gordon H. Hardy, and Ronald M. Gerdes (SYRE Corp., Moffett Field, CA.) Apr. 1991 34 p
(NASA-TM-102853; A-90247; NAS 1.15:102853) Avail: NTIS HC/MF A03 CSCL 01C

An exponential-deceleration speed guidance law is formulated which mimics the technique currently used by Harrier pilots to perform decelerating approaches to a hover. This guidance law was tested along with an existing two-step constant deceleration speed guidance law, using a fixed-base piloted simulator programmed to represent a YAV-8B Harrier. Decelerating approaches to a hover at a predetermined station-keeping point were performed along a straight (-3 deg glideslope) path in headwinds up to 40 knots and turbulence up to 6 ft./sec. Visibility was fixed at one-quarter nautical mile and 100 ft. cloud ceiling. Three Harrier pilots participated in the experiment. Handling qualities with the aircraft equipped with the standard YAV-8B rate damped attitude stability augmentation system were adequate (level 2) using either speed guidance law. However, the exponential deceleration speed guidance law was rated superior to the constant-deceleration speed guidance law by a Cooper-Harper handling qualities rating of about one unit independent of the level of wind and turbulence. Replacing the attitude control system of the YAV-8B with a high fidelity model following attitude flight controller increased the approach accuracy and reduced the pilot workload. With one minor exception, the handling qualities for the approach were rated satisfactory (level 1). It is concluded that the exponential deceleration speed guidance law is the most cost effective. Author

N91-24210*# Sparta, Inc., Laguna Hills, CA.
NATIONAL REMOTE COMPUTATIONAL FLIGHT RESEARCH FACILITY
Herman A. Rediess Sep. 1989 85 p
(Contract NAS2-12211)
(NASA-CR-179432; H-1489; NAS 1.26:179432) Avail: NTIS HC/MF A05 CSCL 01C

The extension of the NASA Ames-Dryden remotely augmented vehicle (RAV) facility to accommodate flight testing of a hypersonic aircraft utilizing the continental United States as a test range is investigated. The development and demonstration of an automated flight test management system (ATMS) that uses expert system technology for flight test planning, scheduling, and execution is documented. Author

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

N91-24211*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ADVANCED HYPERVELOCITY AEROPHYSICS FACILITY WORKSHOP
Robert D. Witcofski, comp. and William I. Scallion, comp. May 1989 170 p Workshop held in Hampton, VA, 10-11 May 1988
(NASA-CP-10031; NAS 1.55:10031) Avail: NTIS HC/MF A08 CSCL 14B

The primary objective of the workshop was to obtain a critical assessment of a concept for a large, advanced hypervelocity ballistic range test facility powered by an electromagnetic launcher, which was proposed by the Langley Research Center. It was concluded that the subject large-scale facility was feasible and would provide the required ground-based capability for performing tests at entry flight conditions (velocity and density) on large, complex, instrumented models. It was also concluded that advances in remote measurement techniques and particularly onboard model instrumentation, light-weight model construction techniques, and model electromagnetic launcher (EML) systems must be made before any commitment for the construction of such a facility can be made. Author

N91-24212*# Remtech, Inc., Huntsville, AL.
BOUNDARY LAYER SIMULATOR IMPROVEMENT Final Report
Sarat C. Praharaj, Craig P. Schmitz, and Joseph A. Nouri 31 Mar. 1989 145 p
(Contract NAS8-36551)
(NASA-CR-183660; NAS 1.26:183660; RTR-161-01) Avail: NTIS HC/MF A07 CSCL 14B

Boundary Layer Integral Matrix Procedure (BLIMPJ) has been identified by the propulsion community as the rigorous boundary layer program in connection with the existing JANNAF reference programs. The improvements made to BLIMPJ and described herein have potential applications in the design of the future Orbit Transfer Vehicle engines. The turbulence model is validated to include the effects of wall roughness and a way is devised to treat multiple smooth-rough surfaces. A prediction of relaminarization regions is examined as is the combined effects of wall cooling and surface roughness on relaminarization. A turbulence model to represent the effects of constant condensed phase loading is given. A procedure is described for thrust decrement calculation in thick boundary layers by coupling the T-D Kinetics Program and BLIMPJ and a way is provided for thrust loss optimization. Potential experimental studies in rocket nozzles are identified along with the required instrumentation to provide accurate measurements in support of the presented new analytical models. Author

N91-24133*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NATIONAL TRANSONIC FACILITY STATUS
L. W. McKinney, W. E. Bruce, Jr., and B. B. Gloss *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 Apr. 1989 p 1-39 (For primary document see N91-24132 16-02)
Avail: NTIS HC/MF A11 CSCL 14B

N91-24287# Fluidyne Engineering Corp., Minneapolis, MN.
A SUMMARY OF EUROPEAN AND JAPANESE HYPERSONIC FACILITY ACTIVITIES
D. G. DeCoursin *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 203-210 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

N91-24288*# GT-Devices, Alexandria, VA.
HIGH PRESSURE MACH 10 TO 20 ELECTROTHERMAL HYPERSONIC WIND TUNNEL
R. L. Burton, F. D. Witherspoon, O. Rizkalla, and W. Chinitz (General Applied Science Labs., Inc., Ronkonkoma, NY.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 211-226 (For primary document see N91-24273 16-20)
(Contract NAS1-18450)
Avail: NTIS HC/MF A20 CSCL 14B

12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

N91-24213# Technion - Israel Inst. of Tech., Haifa. Inst. for Advanced Studies in Science and Technology.
SURVEY OF THE POSSIBILITIES FOR EXPLOITING SPACE FOR CIVIL OBJECTIVES Progress Report, Nov. 1986 - Mar. 1987 [SEKIRAT EFSHARUYOT NITZUL HACHALAL LEMATAROT EZRACHIYOT]
E. Golod Apr. 1987 43 p In HEBREW
(ITN-90-85017) Copyright Avail: NTIS HC/MF A03

A survey was carried out of the possibilities for the technological exploitation of space for civilian objectives. It covered the uses of space for material processing under conditions of vacuum and microgravity, communications via satellites and navigation and earth-observation systems. Emphasized were the importance and significance of activities in the space field to the international economic and industrial systems. Civilian activities in space in various countries were examined. The main conclusions of the survey were: (1) Civilian space operations worldwide have great economic and industrial significance, which is not confined to those countries with direct connections with these operations; (2) In the coming decades the influence of space activities on the level of world technology will be comparable with that of the aviation industry in the 40's and 50's; (3) Space operations are very expensive and force international cooperation in order to support the outlays; and (4) In all countries in which space activities are organized, the activities are organized by governmental networks, either directly by government departments or by governmental authorities subordinate to government departments. ISA

N91-24387*# Arizona Univ., Tucson. Aerospace and Mechanical Engineering.
DEVELOPMENT OF A FIGURE-OF-MERIT FOR SPACE MISSIONS
Bruce Preiss, Thomas Pan, and Kumar Ramohalli *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 6 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 22A

13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

N91-24214# National Geodetic Survey, Rockville, MD. Charting and Geodetic Services.
A PROGRADE GEOSAT EXACT REPEAT MISSION
Carl Wagner Aug. 1990 19 p
(PB91-136754; NOAA-TM-NOS-NGS-54) Avail: NTIS HC/MF A03 CSCL 22A

Prograde/retrograde orbit pairs that yield close ground tracks at low latitudes are cited for Exact Repeat Missions (ERM). In particular, the prograde orbit which most closely matches the Geosat ERM (108 deg inclination) is found to have an inclination of 65.1 deg. This orbit can stay within +/- 10 km of the Geosat ERM ground track to +/- 28 deg latitude. The objective is to

duplicate this well-covered retrograde track as much as possible, thereby maximizing its oceanographic use in the event another retrograde mission will not be possible. A prograde Geosat ERM can support a heavier satellite and allow the P(1) tide to be determined from collinear altimetry, as compared to the current mission which tracks to somewhat higher latitudes and on which the P(1) tide is stationary. Author

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

N91-24623*# Lockheed Space Operations Co., Cocoa Beach, FL.
SPACE SHUTTLE HOLDDOWN POST BLAST SHIELD
F. B. Larracas *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 291-306 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 09B

15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

N91-24215# Mardon (Austin Albert), Lethbridge (Alberta).
COMMERCIAL ASPECTS OF THE LONG MARCH LAUNCH SYSTEM
Austin Albert Mardon 1990 29 p
(PB91-135970) Avail: NTIS HC/MF A03 CSCL 22B

The Chinese have moved into the international commercial space business based on the launch capability of the Long March series of rockets. The report briefly describes the following: characteristics of the Long March system and examines the ways in which Long March launch services are marketed; implications surrounding proposed payloads containing U.S.-developed technology; reasons why the Chinese are maintaining a strong presence in the world commercial space market; areas in which the Chinese are interested in expanding their space commercialization business; and the prospects of Chinese-Japanese cooperation. GRA

N91-24607*# General Dynamics Corp., San Diego, CA. Space Systems Div.
DESIGN AND DEVELOPMENT OF THE REDUNDANT LAUNCHER STABILIZATION SYSTEM FOR THE ATLAS 2 LAUNCH VEHICLE
M. Nakamura *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 45-60 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 22B

N91-24621*# Honeywell, Inc., Glendale, AZ. Satellite Systems Operations.
PAYLOAD SPIN ASSEMBLY FOR THE COMMERCIAL TITAN LAUNCH VEHICLE
Wilf Robinson and Greg Pech (Martin Marietta Corp., Denver, CO.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 253-274 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 22B

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

N91-24216*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
LOAD LIMITING, ENERGY ABSORBING, LIGHTWEIGHT DEBRIS CATCHER Patent Application
Jon B. Kahn, inventor (to NASA) and William C. Schneider, inventor (to NASA) 22 Feb. 1991 25 p
(NASA-Case-MSC-21562-1; NAS 1.71:MSC-21562-1; US-Patent-Appl-SN-658911) Avail: NTIS HC/MF A03 CSCL 22B

In the representative embodiment of the invention disclosed a load limiting, energy absorbing net is arranged to overlay a normally-covered vent opening in the rear bulkhead of the space orbiter vehicle. Spatially-disposed flexible retainer straps are extended from the net and respectively secured to bulkhead brackets spaced around the vent opening. The intermediate portions of the straps are doubled over and stitched together in a pattern enabling the doubled-over portions to progressively separate at a predicable load designed to be well below the tensile capability of the straps as the stitches are successively torn apart by the forces imposed on the retainer members whenever the cover plate is explosively separated from the bulkhead and propelled into the net. By arranging these stitches to be successively torn away at a load below the strap strength in response to forces acting on the retainers that are less than the combined strength of the retainers, this tearing action serves as a predictable compact energy absorber for safely halting the cover plate as the retainers are extended as the net is deployed. The invention further includes a block of an energy-absorbing material positioned in the net for receiving loose debris produced by the explosive release of the cover plate. NASA

N91-24217*# Southwest Research Inst., San Antonio, TX.
SEPAC DATA ANALYSIS IN SUPPORT OF THE ENVIRONMENTAL INTERACTION PROGRAM Final Technical Report
C. S. Lin 31 Mar. 1991 51 p
(Contract NAS8-32488; SwRI Proj. 15-4865-009)
(NASA-CR-188179; NAS 1.26:188179) Avail: NTIS HC/MF A04 CSCL 22B

The main objective is to conduct data analyses of SEPAC data and computer modeling to investigate spacecraft environment effects associated with injection of electron beam, plasma clouds, and neutral gas clouds from the Shuttle Orbiter. To understand the dependence of spacecraft charging potential on beam density and other plasma parameters, a two dimensional electrostatic particle code was used to simulate the injection of electron beams from an infinite conductor into a plasma. The ionization effects on spacecraft charging are examined by including interactions of electrons with neutral gases. A survey of the simulation results is presented and discussed. Author

N91-24218*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
DEBRIS/ICE/TPS ASSESSMENT AND PHOTOGRAPHIC ANALYSIS FOR SHUTTLE MISSION STS-37
Gregory N. Katnik, Scott A. Higginbotham, and J. Bradley Davis Apr. 1991 163 p Original contains color illustrations
(NASA-TM-103818; NAS 1.15:103818) Avail: NTIS HC/MF A08; 56 functional color pages CSCL 22A

A debris/Ice/TPS assessment and photographic analysis was conducted for Space Shuttle Mission STS-37. Debris inspections of the flight elements and launch pad were performed before and after launch. Ice/frost conditions on the External Tank were assessed by the use of computer programs, nomographs, and infrared scanner data during cryogenic loading of the vehicle

followed by on-pad visual inspection. High speed photography of launch was analyzed to identify ice/debris sources and evaluate potential vehicle damage and/or inflight anomalies. The debris/TPS conditions and photographic analysis of Mission STS-57 are documented, along with their overall effect on the Space Shuttle Program. Author

N91-24219# Photometrics, Inc., Woburn, MA.
PHOTOMETRIC-PHOTOGRAMMETRIC ANALYSIS OF VIDEO IMAGES OF A VENTING OF WATER FROM SPACE SHUTTLE DISCOVERY Technical Report, 31 May 1989 - 31 May 1990
I. L. Kofsky, N. H. Tran, M. A. Maris, D. L. Rall, and C. A. Trowbridge 15 Jun. 1990 88 p
(Contract F19628-88-C-0070)
(AD-A233452; PHM-P-08-90; GL-TR-90-0187; SR-2) Avail: NTIS HC/MF A05 CSCL 20/6

The patterns of scattering of visible sunlight by ice particles that formed from fuel cell product water vented just before dawn into the wake of Shuttle Orbiter are photometrically reduced and analyzed. This initially coherent heated liquid stream breaks up within approx. 1 m from the nozzle into irregular polydisperse drops of mean size comparable with its initial 1-1/2 microns diameter (much as was observed in laboratory simulations), which are accompanied by a much less dense cloud of submicron ice droplets produced when the evaporated/sublimed water gas overexpands and partially recondenses. Discrete large drops dominate the images of the backlit trail taken by intensified-video cameras onboard the spacecraft, while the radiance from the efficiently scattering small particles is responsible for virtually all of the signal at a long focus (1/2 deg field) camera precisely tracked on the spacecraft from the Air Force Maui (mountaintop) Optical Station. The mean radius was calculated of these smaller ice particles along the approx. 2 1/2 km of detectable trail from the video photocurrent distribution and their radiative evaporative energy balance in the low earth orbital environment, finding that application of a small correction for surface roughening (such as was seen in laboratory experiments) would fit the sublimation rates. The small ice particles transition from geometric (Mie) to Rayleigh scattering over this trajectory (relative to the spacecraft). GRA

N91-24220*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FEASIBILITY ANALYSIS OF CISLUNAR FLIGHT USING THE SHUTTLE ORBITER
Davy A. Haynes Jun. 1991 24 p
(NASA-TM-104084; NAS 1.15:104084) Avail: NTIS HC/MF A03 CSCL 22B

A first order orbital mechanics analysis was conducted to examine the possibility of utilizing the Space Shuttle Orbiter to perform payload delivery missions to lunar orbit. In the analysis, the earth orbit of departure was constrained to be that of Space Station Freedom. Furthermore, no enhancements of the Orbiter's thermal protection system were assumed. Therefore, earth orbit insertion maneuvers were constrained to be all propulsive. Only minimal constraints were placed on the lunar orbits and no consideration was given to possible landing sites for lunar surface payloads. The various phases and maneuvers of the mission are discussed for both a conventional (Apollo type) and an unconventional mission profile. The velocity impulses needed, and the propellant masses required are presented for all of the mission maneuvers. Maximum payload capabilities were determined for both of the mission profiles examined. In addition, other issues relating to the feasibility of such lunar shuttle missions are discussed. The results of the analysis indicate that the Shuttle Orbiter would be a poor vehicle for payload delivery missions to lunar orbit. Author

N91-24221*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
DEBRIS/ICE/TPS ASSESSMENT AND PHOTOGRAPHIC ANALYSIS FOR SHUTTLE MISSION STS-39
Gregory N. Katnik, Scott A. Higginbotham, and J. Bradley Davis Jun. 1991 158 p Original contains color illustrations
(NASA-TM-103820; NAS 1.15:103820) Avail: NTIS HC/MF A08; 56 functional color pages CSCL 22B

A Debris/Ice/TPS (thermal protection system) assessment and photographic analysis was conducted for Space Shuttle Mission STS-39. Debris inspections of the flight elements and launch pad were performed before and after launch. Ice/frost conditions on the external tank were assessed by the use of computer programs, nomographs, and infrared scanner data during cryogenic loading of the vehicle followed by on-pad visual inspection. High speed photography of launch was analyzed to identify ice/debris anomalies. The debris/ice/TPS conditions and photographic analysis of Mission STS-39, and their overall effect on the Space Shuttle Program are documented. Author

17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

No abstracts in this category.

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

N91-24222*# Harris Corp., Melbourne, FL. Government Aerospace Systems Div.
HIGH PERFORMANCE, ACCELEROMETER-BASED CONTROL OF THE MINI-MAST STRUCTURE AT LANGLEY RESEARCH CENTER Final Report
Emmanuel G. Collins, Jr., James A. King, Douglas J. Phillips, and David C. Hyland Washington NASA May 1991 98 p
(Contract NAS1-18872)
(NASA-CR-4377; NAS 1.26:4377) Avail: NTIS HC/MF A05 CSCL 22B

Many large space system concepts will require active vibration control to satisfy critical performance requirements such as line of sight pointing accuracy and constraints on rms surface roughness. In order for these concepts to become operational, it is imperative that the benefits of active vibration control be shown to be practical in ground based experiments. The results of an experiment shows the successful application of the Maximum Entropy/Optimal Projection control design methodology to active vibration control for a flexible structure. The testbed is the Mini-Mast structure at NASA-Langley and has features dynamically traceable to future space systems. To maximize traceability to real flight systems, the controllers were designed and implemented using sensors (four accelerometers and one rate gyro) that are actually mounted to the structure. Ground mounted displacement sensors that could greatly ease the control design task were available but were used only for performance evaluation. The use of the accelerometers increased the potential of destabilizing the system due to spillover effects and motivated the use of precompensation strategy to achieve sufficient compensator roll-off. Author

N91-24223# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
ANALYSIS OF METHODS FOR THE CALCULATION OF AERODYNAMIC CHARACTERISTICS OF ARTIFICIAL SATELLITE REENTRY MODELS [ANALISE DE METODOS PARA O CALCULO DAS CARACTERISTICAS AERODINAMICAS DE MODELOS DE SATELITES ARTIFICIAIS REENTRAVEIS]
Otavio AugustodeAzevedoCampos and Hans-Ulrich Pilchowski Nov. 1990 17 p In PORTUGESE Presented at the 1st Brazilian Symposium of Aerospace Technology, Sao Jose dos Campos, Brazil, 27-31 Aug. 1990
(INPE-5185-PRE/1653) Avail: NTIS HC/MF A03

A comparative study was done of the methods utilized in the calculation of aerodynamic coefficients of bodies subjected to supersonic flow, as in the case of artificial satellite re-entry. The geometry of interest is a conical body with a blunt lip or ogive type, that is axisymmetrical. The Newton-Belotserkovski method was utilized and was compared with experimental values, obtained in wind tunnels. Transl. by B.G.

N91-24224*# Sverdrup Technology, Inc., Brook Park, OH.
A CHARGING STUDY OF ACTS USING NASCAP Final Report
Joel L. Herr May 1991 12 p Presented at the 22nd Fluid Dynamics, Plasma Dynamics, and Lasers Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(Contract NAS3-25266)
(NASA-CR-187088; E-6079; NAS 1.26:187088) Avail: NTIS HC/MF A03 CSCL 22B

The NASA Charging Analyzer Program (NASCAP) computer code is a three dimensional finite element charging code designed to analyze spacecraft charging in the magnetosphere. Because of the characteristics of this problem, NASCAP can use an quasi-static approach to provide a spacecraft designer with an understanding of how a specific spacecraft will interact with a geomagnetic substorm. The results of the simulation can help designers evaluate the probability and location of arc discharges of charged surfaces on the spacecraft. A charging study of NASA's Advanced Communication Technology Satellite (ACTS) using NASCAP is reported. The results show that the ACTS metalized multilayer insulating blanket design should provide good electrostatic discharge control. Author

N91-24225*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ENVIRONMENTAL INTERACTIONS OF THE SPACE STATION FREEDOM ELECTRIC POWER SYSTEM
Henry K. Nahra and Cheng-Yi Lu (Rockwell International Corp., Canoga Park, CA.) 1991 8 p Presented at the European Space Power Conference, Florence, Italy, 2-6 Sep. 1991; sponsored by ESA, the Politecnico di Milana, the Italian Space Agency, and the European Power Electronics
(NASA-TM-104373; E-6177; NAS 1.15:104373) Avail: NTIS HC/MF A02 CSCL 10B

The Space Station Freedom operates in a low earth orbit (LEO) environment. Such operation results in different potential interactions with the Space Station systems including the Electric Power System (EPS). These potential interactions result in environmental effects which include neutral species effects such as atomic oxygen erosion, effects of micrometeoroid and orbital debris impacts, plasma effects, ionizing radiation, and induced contamination degradation effects. The EPS design and its interactions with the LEO environment are briefly described and the results of analyses and testing programs planned and performed thus far to resolve environmental concerns related to the EPS and its function in LEO environment. Author

N91-24226*# Sverdrup Technology, Inc., Brook Park, OH.
TROUBLE 3: A FAULT DIAGNOSTIC EXPERT SYSTEM FOR SPACE STATION FREEDOM'S POWER SYSTEM Final Report
David B. Manner Cleveland, OH NASA [1990] 54 p
(Contract NAS3-25266)
(NASA-CR-187113; E-6188; NAS 1.26:187113) Avail: NTIS HC/MF A04 CSCL 10B

Designing Space Station Freedom has given NASA many opportunities to develop expert systems that automate onboard operations of space based systems. One such development, TROUBLE 3, an expert system that was designed to automate the fault diagnostics of Space Station Freedom's electric power system is described. TROUBLE 3's design is complicated by the fact that Space Station Freedom's power system is evolving and changing. TROUBLE 3 has to be made flexible enough to handle changes with minimal changes to the program. Three types of expert systems were studied: rule-based, set-covering, and model-based. A set-covering approach was selected for TROUBLE 3 because if offered the needed flexibility that was missing from the other approaches. With this flexibility, TROUBLE 3 is not limited to Space Station Freedom applications, it can easily be adapted to handle any diagnostic system. Author

N91-24227*# Boeing Co., Seattle, WA. Defense and Space Group.
ADVANCED DEVELOPMENT RECEIVER THERMAL VACUUM TESTS WITH COLD WALL Final Report
Leigh M. Sedgwick Jun. 1991 282 p
(Contract NAS3-25716)
(NASA-CR-187092; NAS 1.26:187092; D180-32816-1) Avail: NTIS HC/MF A13 CSCL 22B

The first ever testing of a full size solar dynamic heat receiver using high temperature thermal energy storage was completed. The heat receiver was designed to meet the requirements for operation on the Space Station Freedom. The purpose of the test program was to quantify the receiver thermodynamic performance, its operating temperatures, and thermal response to changes in environmental and power module interface boundary conditions. The heat receiver was tested in a vacuum chamber with liquid nitrogen cold shrouds and an aperture cold plate to partially simulate a low Earth orbit environment. The cavity of the receiver was heated by an infrared quartz lamp heater with 30 independently controllable zones to produce flux distributions typical of candidate concentrators. A closed Brayton cycle engine simulator conditioned a helium xenon gas mixture to specific interface conditions to simulate various operational modes of the solar dynamic power module. Inlet gas temperature, pressure, and flow rate were independently varied. A total of 58 simulated orbital cycles were completed during the test conduct period. The test hardware, execution of testing, test data, and post test inspections are described. Author

N91-24228 Department of the Navy, Washington, DC.
PASSIVE STEP TRIMMER FOR A MANEUVERING REENTRY BODY Patent
Ralph M. Darden, inventor (to Navy) 15 Nov. 1988 5 p Filed 12 Feb. 1979
(AD-D014828; US-Patent-4,784,350; US-Patent-Appl-SN-022125; US-Patent-Class-244-3.1) Avail: US Patent and Trademark Office CSCL 22/2

A passive step trimmer is disclosed for a maneuvering re-entry body (MRB) which uses existing inertial forces acting on the MRB to deploy a free flowing mass from the rear of the MRN to trim the MRB altitude. The mass deployment from the MRB causes a forward shift in the center of gravity which in turn created a more stable body which flies at a reduced angle of attack. GRA

N91-24229*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESIGN, FABRICATION, AND TESTS OF A METALLIC SHELL TILE THERMAL PROTECTION SYSTEM FOR SPACE TRANSPORTATION
Ian O. MacConochie and H. Neale Kelly Jun. 1989 27 p
(NASA-TM-101537; NAS 1.15:101537) Avail: NTIS HC/MF A03 CSCL 22B

A thermal protection tile for earth-to-orbit transports is described. The tiles consist of a rigid external shell filled with a flexible insulation. The tiles tend to be thicker than the current Shuttle

rigidized silica tiles for the same entry heat load but are projected to be more durable and lighter. The tiles were thermally tested for several simulated entry trajectories. Author

N91-24262# Atlantic Research Corp., Niagara Falls, NY. Liquid Propulsion.
COMPOSITE OVERWRAP POSITIVE EXPULSION PROPELLANT TANKS
W. A. Sanscrainte and L. K. West (Aerojet TechSystems Co., Sacramento, CA.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 307-315 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

N91-24974*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LDEF SPACE ENVIRONMENTS OVERVIEW Abstract Only
William H. Kinard *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 4 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

N91-24976*# Science Applications International Corp., Glendora, CA.
MEASURED SPACE ENVIRONMENTAL EFFECTS TO LDEF DURING RETRIEVAL Abstract Only
Carl R. Maag and W. Kelly Linder (Space Systems Div. AFSC Field Office, Houston, TX.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 6 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

N91-24977*# Boeing Aerospace and Electronics Co., Seattle, WA.
MIGRATION AND GENERATION OF CONTAMINANTS FROM LAUNCH THROUGH RECOVERY: LDEF CASE HISTORY Abstract Only
E. Russ Crutcher, L. S. Nishimura, K. J. Warner, and W. W. Wascher *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 7 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

N91-24978*# Boeing Co., Washington, DC. Defense and Space Group.
LDEF CONTAMINANTS ANALYSIS DATA Abstract Only
E. Russ Crutcher, K. J. Warner, W. W. Washer, and L. S. Nishimura *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 8 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

N91-24979*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ORGANIC CONTAMINATION OF LDEF Abstract Only
Gale A. Harvey *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 9 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

N91-25088*# AZ Technology, Huntsville, AL.
THERMAL CONTROL SURFACES EXPERIMENT (SOO69) FLIGHT SYSTEMS PERFORMANCE Abstract Only
Donald R. Wilkes and Leigh L. Hummer *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 122 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

N91-25097*# American Space Technology, Inc., Santa Monica, CA.
RETRIEVABLE PAYLOAD CARRIER (RPC): NEXT GENERATION LONG DURATION EXPOSURE FACILITY Abstract Only
Arthur T. Perry *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 132 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

N91-25098*# The Land, Lake Buena Vista, FL.
SURVIVAL OF EPIPHYTIC BACTERIA FROM SEED STORED ON THE LONG DURATION EXPOSURE FACILITY (LDEF) Abstract Only
Andrew C. Schuerger, Bret L. Norman, and Joseph A. Angelo, Jr. (Science Applications International Corp., Melbourne, FL.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 133 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

N91-24606*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
DEAD-BLOW HAMMER DESIGN APPLIED TO A CALIBRATION TARGET MECHANISM TO DAMPEN EXCESSIVE REBOUND
Brian Y. Lim *In its* The 25th Aerospace Mechanisms Symposium May 1991 p 31-44 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 14B

N91-24610*# Ball Corp., Boulder, CO. Electro-Optics/Cryogenics Div.
POINTING/ROLL MECHANISM FOR THE ULTRAVIOLET CORONAGRAPH SPECTROMETER
Miroslaw A. Ostaszewski and Larry J. Guy *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 93-105 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 14B

20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

N91-24230*# Aerojet-General Corp., Sacramento, CA. Propulsion Div.
USER'S MANUAL FOR ROCKET COMBUSTOR INTERACTIVE DESIGN (ROCCID) AND ANALYSIS COMPUTER PROGRAM. VOLUME 1: USER'S MANUAL Final Report
J. A. Muss, T. V. Nguyen, and C. W. Johnson (Software and Engineering Associates, Inc., Carson City, NV.) May 1991 92 p
(Contract NAS3-25556)
(NASA-CR-187109; NAS 1.26:187109) Avail: NTIS HC/MF A05 CSCL 21H

The user's manual for the rocket combustor interactive design (ROCCID) computer program is presented. The program, written in Fortran 77, provides a standardized methodology using state of the art codes and procedures for the analysis of a liquid rocket engine combustor's steady state combustion performance and combustion stability. The ROCCID is currently capable of analyzing mixed element injector patterns containing impinging like doublet or unlike triplet, showerhead, shear coaxial, and swirl coaxial elements as long as only one element type exists in each injector core, baffle, or barrier zone. Real propellant properties of oxygen, hydrogen, methane, propane, and RP-1 are included in ROCCID.

The properties of other propellants can easily be added. The analysis model in ROCCID can account for the influence of acoustic cavities, helmholtz resonators, and radial thrust chamber baffles on combustion stability. ROCCID also contains the logic to interactively create a combustor design which meets input performance and stability goals. A preliminary design results from the application of historical correlations to the input design requirements. The steady state performance and combustion stability of this design is evaluated using the analysis models, and ROCCID guides the user as to the design changes required to satisfy the user's performance and stability goals, including the design of stability aids. Output from ROCCID includes a formatted input file for the standardized JANNAF engine performance prediction procedure. Author

N91-24231*# Aerojet-General Corp., Sacramento, CA. Propulsion Div.

USER'S MANUAL FOR ROCKET COMBUSTOR INTERACTIVE DESIGN (ROCCID) AND ANALYSIS COMPUTER PROGRAM. VOLUME 2: APPENDIXES A-K Final Report

J. A. Muss, T. V. Nguyen, and C. W. Johnson (Software and Engineering Associates, Inc., Carson City, NV.) May 1991 578 p

(Contract NAS3-25556)

(NASA-CR-187110; NAS 1.26:187110) Avail: NTIS HC/MF A25 CSCL 21H

The appendices A-K to the user's manual for the rocket combustor interactive design (ROCCID) computer program are presented. This includes installation instructions, flow charts, subroutine model documentation, and sample output files. The ROCCID program, written in Fortran 77, provides a standardized methodology using state of the art codes and procedures for the analysis of a liquid rocket engine combustor's steady state combustion performance and combustion stability. The ROCCID is currently capable of analyzing mixed element injector patterns containing impinging like doublet or unlike triplet, showerhead, shear coaxial and swirl coaxial elements as long as only one element type exists in each injector core, baffle, or barrier zone. Real propellant properties of oxygen, hydrogen, methane, propane, and RP-1 are included in ROCCID. The properties of other propellants can be easily added. The analysis models in ROCCID can account for the influences of acoustic cavities, helmholtz resonators, and radial thrust chamber baffles on combustion stability. ROCCID also contains the logic to interactively create a combustor design which meets input performance and stability goals. A preliminary design results from the application of historical correlations to the input design requirements. The steady state performance and combustion stability of this design is evaluated using the analysis models, and ROCCID guides the user as to the design changes required to satisfy the user's performance and stability goals, including the design of stability aids. Output from ROCCID includes a formatted input file for the standardized JANNAF engine performance prediction procedure. Author

N91-24232*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DESIGN OF MULTIHUNDREDWATT DIPS FOR ROBOTIC SPACE MISSIONS

D. J. Bents, S. M. Geng, J. G. Schreiber, C. A. Withrow, P. C. Schmitz, and Thomas J. McComas (Florida Univ., Gainesville.) 1991 8 p Proposed for presentation at the 26th Intersociety Energy Conversion Conference, Boston, MA, 4-9 Aug. 1991; cosponsored by ANS, SAE, ACS, AIAA, ASME, IEEE, and AIChE

(Contract NAS3-25266)

(NASA-TM-104401; E-6216; NAS 1.15:104401) Avail: NTIS HC/MF A02 CSCL 21H

Design of a dynamic isotope power system (DIPS) general purpose heat source (GPHS) and small free piston Stirling engine (FPSE) is being pursued as a potential lower cost alternative to radioisotope thermoelectric generators (RTG's). The design is targeted at the power needs of future unmanned deep space and planetary surface exploration missions ranging from scientific probes to SEI precursor missions. These are multihundredwatt missions. The incentive for any dynamic system is that it can save fuel which reduces cost and radiological hazard. However, unlike a conventional DIPS based on turbomachinery converions, the small Stirling DIPS can be advantageously scaled to multihundred watt unit size while preserving size and weight competitiveness with RTG's. Stirling conversion extends the range where dynamic systems are competitive to hundreds of watts (a power range not previously considered for dynamic systems). The challenge of course is to demonstrate reliability similar to RTG experience. Since the competative potential of FPSE as an isotope converter was first identified, work has focused on the feasibility of directly integrating GPHS with the Stirling heater head. Extensive thermal modeling of various radiatively coupled heat source/heater head geometries were performed using data furnished by the developers of FPSE and GPHS. The analysis indicates that, for the 1050 K heater head configurations considered, GPHS fuel clad temperatures remain within safe operating limits under all conditions including shutdown of one engine. Based on these results, preliminary characterizations of multihundred watt units were established. Author

N91-24233# Johns Hopkins Univ., Columbia, MD. Chemical Propulsion Information Agency.

THE 1990 JANNAF PROPULSION MEETING, VOLUME 2

Karen L. Brown, ed. and Debra S. Eggleston, ed. Oct. 1990 460 p Meeting held in Anaheim, CA, 3-5 Oct. 1990

(Contract N00014-91-C-0001)

(CPIA-Publ-550-Vol-2) Avail: NTIS HC/MF A20

This volume, 2 of 6, is a collection of 39 papers presented at the conference. Specific subjects discussed include nondestructive evaluation, launch vehicle propulsion, space shuttle engines, hybrid propulsion technology, liquid rocket engines, attitude control engines, and electric propulsion systems. For individual titles, see N91-24234 through N91-24272.

N91-24234*# United Space Boosters, Inc., Huntsville, AL. Materials and Processes Technology.

NDE OF THERMAL PROTECTION SYSTEM FOR SPACE SHUTTLE SOLID ROCKET BOOSTER

R. S. Myers *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 1-10 Sponsored in part by NASA. Marshall Space Flight Center; NASA. Langley Research Center; United Technologies Corp.; USBI; Pratt and Whitney; United Technologies Research Center; Amdata; American Science and Engineering, Inc; DuPont NDT Systems; EG and (For primary document see N91-24233 16-20)

Avail: NTIS HC/MF A20 CSCL 21H

Potential nondestructive test (NDE) methods were evaluated for detecting debonds and weak bonds in the thermal protection system (TPS) for the space shuttle solid rocket boosters. The primary thermal protection material is a sprayable, thick epoxy coating that is filled with lightweight and thermal insulating materials. Test panels were fabricated with a wide variety of hidden realistic defects, including contact debonds and weak bonds. Nondestructive test results were obtained. Candidate NDE methods evaluated for booster production applications include laser interferometry (e.g., electronic shearography), infrared thermography, radiography (e.g., computed tomography), acousto-ultrasonics, mechanical/acoustic impedance, ultrasonics, acoustic emission, and the tap test. Capabilities, advantages, disadvantages, and relative performances in defect detection of each test method for TPS bonding applications are reported. Electronic shearography NDE was technically the superior method for detecting debonds. Author

N91-24235# Irvine Technology Group, Inc., Fullerton, CA.

AIRBREATHING BOOSTER PERFORMANCE OPTIMIZATION USING A MICROCOMPUTER

R. E. Oglevie and L. R. Carreiro (Air Force Aero Propulsion Lab., Wright-Patterson AFB, OH.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 11-20 (For primary document see N91-24233 16-20)

(Contract F33615-89-C-2935)
Avail: NTIS HC/MF A20

Airbreathing, lifting, reusable boosters offer promise of providing low cost space transportation. The design of these hypersonic systems is complex and performance optimization is crucial to their success. Available trajectory optimization programs are cumbersome for rapid preliminary design, requiring considerable expertise and resources for their application. A simple, fast-running, trajectory and performance optimization tool, suitable for preliminary design, was sought. The features of such a tool include: (1) operation on personal computers (PC) with run time less than 5 minutes on an AT model; (2) propulsion system application focus, including airbreathing and rocket systems; (3) multiple stage, lifting body vehicles (Aerospace Plane type); and (4) Earth-to-orbit (ETO) flight, including horizontal takeoff, powered ascent, and orbit insertion. The resulting Microcomputer-based Optimization of Simulated Trajectories (MOST) program features an energy method for rapid computation of optimal flight states. Testing of these simple algorithms showed them to be quite robust when compared with more traditional optimization programs. The program's simulation structure provides for easy and flexible creation of a wide variety of missions, without need for extensive programming or optimization expertise. A comparison of MOST results with data from other programs is given. It is concluded that simple PC-based optimization methods can provide powerful and reasonably accurate tools for preliminary design. Author

N91-24236# McDonnell-Douglas Space Systems Co., Huntington Beach, CA.
IMPACT OF PROPULSIVE ADVANCEMENTS ON CAPABILITIES OF REUSABLE EARTH-TO-ORBIT SHIPS
H. D. Froning, Jr. and J. L. Leingang (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 21-30 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

Successful aerospace developments in Europe, Asia, the Orient, and the U.S. are bringing about the possibility of effective, fully reusable vehicles for transport of people and cargo between earth and space. These developments include: extension of airbreathing propulsion to much higher speed; densification of propellants for greater energy per unit volume of mass; structures with much greater strength-to-weight at high temperature and speed; computational advancements that enable more optimal design and integration of airframes, engines and controls; and advances in avionics, robotics, artificial intelligence and automation that enable accomplishment of earth-to-orbit (ETO) operations with much less manpower support and cost. These developments may provide improvement in ETO operations for single and multi-stage vehicles and for rocket and airbreathing flight. Author

N91-24237*# National Aeronautics and Space Administration, Washington, DC.
CRYOGENIC HYDROGEN-INDUCED AIR LIQUEFACTION TECHNOLOGIES
William J. D. Escher *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 31-45 Presented at the 7th AGARD Symposium of the Propulsion and Energetics Panel on Hypersonic Combined Cycle Propulsion, Madrid, Spain, 28 May - 1 Jun. 1990 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

Extensively utilizing a special advanced airbreathing propulsion archives database, as well as direct contacts with individuals who were active in the field in previous years, a technical assessment of cryogenic hydrogen-induced air liquefaction, as a prospective onboard aerospace vehicle process, was performed and documented. The resulting assessment report is summarized. Technical findings are presented relating the status of air liquefaction technology, both as a singular technical area, and also that of a cluster of collateral technical areas including: compact lightweight cryogenic heat exchangers; heat exchanger atmospheric constituents fouling alleviation; para/ortho hydrogen shift conversion catalysts; hydrogen turbine expanders, cryogenic air compressors and liquid air pumps; hydrogen recycling using slush hydrogen as heat sink; liquid hydrogen/liquid air rocket-type combustion devices; air collection and enrichment systems (ACES); and technically related engine concepts. Author

N91-24238# Aerospace Corp., El Segundo, CA.
AN EFFICIENT, INTELLIGENT SOLUTION FOR VISCOUS FLOWS INSIDE SOLID ROCKET MOTORS
I-Shih Chang *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 47-61 (For primary document see N91-24233 16-20)
(Contract F04701-88-C-0089)
Avail: NTIS HC/MF A20

An efficient, intelligent method was developed for the solution of axisymmetric, compressible viscous flows inside solid rocket motors. The method applies an adaptive, unstructured, finite element mesh generation technique and a cell-centered, second-order, flux correction transport scheme for the solution of Navier-Stokes equations. With known, initial motor interior configuration, the solution allows the computational boundaries to be determined intelligently, the finite element meshes and remeshes to be generated efficiently, and the corresponding compressible viscous flow fields to be produced expeditiously. Very good agreement between analysis results and test data was obtained for flow inside the nozzle. Application of the method to analyze flows inside the Titan 4 solid rocket motor upgrade and the Star-48 motor with very complicated chamber and nozzle geometry is illustrated. Author

N91-24239# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
STRUCTURAL DAMPING/ACOUSTIC ATTENUATION OPTIMIZATION VIA NON-OBSTRUCTIVE PARTICLE DAMPING **c39**
H. V. Panossian *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 63-71 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

A novel passive vibration damping technique that is referred to as non-obstructive particle damping (NOPD) is presented. The NOPD technique consists of making small diameter holes (or cavities) at appropriate locations in a non-obstructibe manner inside the main load path of a vibrating structure without affecting its mass, and filling these holes to appropriate levels with particles yielding the maximum damping effectiveness for the desired mode or modes. Powders, spherical, metallic, non-metallic or liquid particles (or mixtures) with different densities, viscosities, and adhesive or cohesive characteristics can be used. Damping optimization can be carried out by selecting the location and size of cavities, based on modal analysis, and by filling the holes to appropriate levels with the right kind of particles, those having such relative sizes with respect to the cavities and that yield the optimal damping effectiveness. Experimental modal surveys were performed on damping various structures, and computer simulations were run on acoustic attenuation by using the NOPD technique. The results of these tests and analyses are presented and briefly discussed. Heuristic evaluations are made that address the advantages and limitations of NOPD and potential applications in military and industrial structures. Author

N91-24240*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EVALUATION OF PROPOSED ROCKET ENGINES FOR EARTH-TO-ORBIT VEHICLES
James A. Martin and Richard D. Kramer (Spectra Research Systems, Inc., Huntsville, AL.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 73-88 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

The objective is to evaluate recently analyzed rocket engines for advanced Earth-to-orbit vehicles. The engines evaluated are full-flow staged combustion engines and split expander engines,

both at mixture ratios at 6 and above with oxygen and hydrogen propellants. The vehicles considered are single-stage and two-stage fully reusable vehicles and the Space Shuttle with liquid rocket boosters. The results indicate that the split expander engine at a mixture ratio of about 7 is competitive with the full-flow staged combustion engine for all three vehicle concepts. A key factor in this result is the capability to increase the chamber pressure for the split expander as the mixture ratio is increased from 6 to 7. Author

N91-24241# Aerospace Corp., El Segundo, CA. Space Transportation Development Directorate.
AN ADVANCED, LOW-COST ENGINE FOR HIGH-THRUST APPLICATIONS
Anthony T. Zachary *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 89-95 (For primary document see N91-24233 16-20)
(Contract F04701-88-C-0089)
Avail: NTIS HC/MF A20

In the search for a low cost engine for the Advanced Launch System (ALS) vehicle, several alternative engine cycles were reviewed and the merits of applying the expander cycle (well demonstrated on the 15,000-lb-thrust RL-10 engine) to launch vehicles and other high thrust systems were examined. Comparisons with competing engine drive cycles are made on such issues as performance, start and cutoff characteristics, effect of turbine drive medium, applicable materials and manufacturing processes, reliability, and other topics of interest. The expander cycle engine appears to have indications of being a potentially low cost, reliable engine. Author

N91-24242# General Dynamics Corp., San Diego, CA. Space Systems Div.
DEVELOPMENT OF LOW COST PROPULSION REQUIREMENTS
R. N. Ford, G. K. Mehta, and P. R. Brennan *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 97-106 (For primary document see N91-24233 16-20)
(Contract F04701-88-C-0110)
Avail: NTIS HC/MF A20

The Advanced Launch System (ALS) program has driven a different set of requirements for the propulsion system because of its emphasis on low system cost and very reliable delivery of payloads to orbit. By using the lessons learned from past launch systems, several areas were identified where easing design requirements for the main engines can allow the attainment of cost goals that were thought impossible a few years ago. Work completed on the ALS program to develop the interface requirements for the main propulsion system is summarized. The importance of an overall systems engineering process to select optimum design conditions for the main engine is demonstrated. This process makes it possible to approach the cost goal of $300 per pound of payload delivered to low earth orbit. The major sensitivities are shown for the propulsion system and the methods used to develop the system effect relationships. Author

N91-24243*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
TEST RESULTS OF THE MODIFIED SPACE SHUTTLE MAIN ENGINE AT THE MARSHALL SPACE FLIGHT CENTER TECHNOLOGY TEST BED FACILITY
J. Cook, D. Dumbacher, M. Ise, and C. Singer *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 107-115 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

A modified space shuttle main engine (SSME), which primarily includes an enlarged throat main combustion chamber with the acoustic cavities removed and a main injector with the stability control baffles removed, was tested. This one-of-a-kind engine's design changes are being evaluated for potential incorporation in the shuttle flight program in the mid-1990's. Engine testing was initiated on September 15, 1988 and has accumulated 1,915 seconds and 19 starts. Testing is being conducted to characterize the engine system performance, combustion stability with the baffle-less injector, and both low pressure oxidizer turbopump (LPOTP) and high pressure oxidizer turbopump (HPOTP) for suction performance. These test results are summarized and compared with the SSME flight configuration data base. Testing of this new generation SSME is the first product from the technology test bed (TTB). Figure test plans for the TTB include the highly instrumented flight configuration SSME and advanced liquid propulsion technology items. Author

N91-24244*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AIRFLOW MODEL TESTING TO DETERMINE THE DISTRIBUTION OF HOT GAS FLOW AND O/F RATIO ACROSS THE SPACE SHUTTLE MAIN ENGINE MAIN INJECTOR ASSEMBLY
L. Mahorter, J. Chik, D. McDaniels, and C. Dill *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 117-126 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

Engine 0209, the certification engine for the new Phase 2+ Hot Gas Manifold (HGM), showed severe deterioration of the Main Combustion Chamber (MCC) liner during hot fire tests. One theory on the cause of the damage held that uneven local distribution of the fuel rich hot gas flow through the main injector assembly was producing regions of high oxidizer/fuel (O/F) ratio near the wall of the MCC liner. Airflow testing was proposed to measure the local hot gas flow rates through individual injector elements. The airflow tests were conducted using full scale, geometrically correct models of both the current Phase 2 and the new Phase 2+ HGMs. Different main injector flow shield configurations were tested for each HGM to ascertain their effect on the pressure levels and distribution of hot gas flow. Instrumentation located on the primary faceplate of the main injector measured hot gas flow through selected injector elements. These data were combined with information from the current space shuttle main engine (SSME) power balances to produce maps of pressure, hot gas flow rate, and O/F ratio near the main injector primary plate. The O/F distributions were compared for the different injector and HGM configurations. Author

N91-24245# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
CONTROL OF CHAMBER HEAT FLUX BY INJECTOR DESIGN
James J. Fang *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 127-131 (For primary document see N91-24233 16-20)
(Contract F04611-86-C-0088)
Avail: NTIS HC/MF A20

Wall heat flux of a liquid propellant rocket combustion chamber is usually determined through empirical means, in which the effect of injector design details is often not rigorously accounted for. Hot-fire test results are reported, showing that the chamber wall heat transfer rate and trend can be drastically altered even with a hardly noticeable change to the design of injection elements in the injector peripheral region. A spray model was used to analytically characterize the propellant spray field to give the insight to the mechanisms responsible for the data trends seen. Author

N91-24246*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
PREDICTION OF THE THRUST PERFORMANCE AND THE FLOWFIELD OF LIQUID ROCKET ENGINES
T.-S. Wang *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 133-142 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

In an effort to improve the current solutions in the design and analysis of liquid propulsive engines, a computational fluid dynamics (CFD) model capable of calculating the reacting flows from the combustion chamber, through the nozzle to the external plume,

was developed. The Space Shuttle Main Engine (SSME) fired at sea level, was investigated as a sample case. The CFD model, FDNS, is a pressure based, non-staggered grid, viscous/inviscid, ideal gas/real gas, reactive code. An adaptive upwinding differencing scheme is employed for the spatial discretization. The upwind scheme is based on fourth order central differencing with fourth order damping for smooth regions, and second order central differencing with second order damping for shock capturing. It is equipped with a CHMQGM equilibrium chemistry algorithm and a PARASOL finite rate chemistry algorithm using the point implicit method. The computed flow results and performance compared well with those of other standard codes and engine hot fire test data. In addition, the transient nozzle flowfield calculation was also performed to demonstrate the ability of FDNS in capturing the flow separation during the startup process. Author

N91-24247*# United Technologies Corp., San Jose, CA. Chemical Systems.
HYBRID PROPULSION TECHNOLOGY PROGRAM
G. E. Jensen and A. L. Holzman *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 143-157 (For primary document see N91-24233 16-20)
(Contract NAS8-37778)
Avail: NTIS HC/MF A20 CSCL 21H

Future launch systems of the United States will require improvements in booster safety, reliability, and cost. In order to increase payload capabilities, performance improvements are also desirable. The hybrid rocket motor (HRM) offers the potential for improvements in all of these areas. The designs are presented for two sizes of hybrid boosters, a large 4.57 m (180 in.) diameter booster duplicating the Advanced Solid Rocket Motor (ASRM) vacuum thrust-time profile and smaller 2.44 m (96 in.), one-quater thrust level booster. The large booster would be used in tandem, while eight small boosters would be used to achieve the same total thrust. These preliminary designs were generated as part of the NASA Hybrid Propulsion Technology Program. This program is the first phase of an eventual three-phaes program culminating in the demonstration of a large subscale engine. The initial trade and sizing studies resulted in preferred motor diameters, operating pressures, nozzle geometry, and fuel grain systems for both the large and small boosters. The data were then used for specific performance predictions in terms of payload and the definition and selection of the requirements for the major components: the oxidizer feed system, nozzle, and thrust vector system. All of the parametric studies were performed using realistic fuel regression models based upon specific experimental data. Author

N91-24248*# Atlantic Research Corp., Gainesville, VA.
A UNIQUE HYBRID PROPULSION SYSTEM DESIGN FOR LARGE SPACE BOOSTERS
Frederick C. Rodgers *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 159-168 (For primary document see N91-24233 16-20)
(Contract NAS8-37776)
Avail: NTIS HC/MF A20 CSCL 21H

A study was made of the application of hybrid rocket propulsion technology to large space boosters. Safety, reliability, cost, and performance comprised the evaluation criteria, in order of relative importance, for this study. The effort considered the so called classic hybrid design approach versus a novel approach which utilizes a fuel-rich gas generator for the fuel source. Other trades included various fuel/oxidizer combinations, pressure-fed versus pump fed oxidizer delivery systems, and reusable versus expandable booster systems. Following this initial trade study, a point design was generated. A gas generated-type fuel grain with pump fed liquid oxygen comprised the basis of this point design. This design study provided a mechanism for considering the means of implementing the gas generator approach for further defining details of the design. Subsequently, a system trade study was performed which determined the sensitivity of the design to various design parameters and predicted optimum values for these same parameters. The study concluded that a gas generator hybrid booster design offers enhanced safety and reliability over current of proposed solid booster designs while providing equal or greater performance levels. These improvements can be accomplished at considerably lower cost than for the liquid booster designs of equivalent capability. Author

N91-24249# General Dynamics Corp., San Diego, CA. Space Systems Div.
HYBRID PROPULSION BOOSTERS FOR SPACE LAUNCH VEHICLES
P. C. Lombrozo, A. L. Schuler, and D. R. Wiley *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 169-176 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

A number of booster propulsion concepts are being considered for the next generation of manned and unmanned space launch vehicles. One propulsion system concept that has potential for reducing costs with increased safety, reliability, and performance is hybrid propulsion. Hybrid propulsion systems incorporate the best features of both liquid and solid propulsion systems. The systems may be thought of as solid propulsion systems with liquid oxidizers, or as liquid propulsion systems with solid fuels. Hybrid propulsion systems will require both acquisition and demonstration to substantiate their promising potential. The systems are readily developed as their foundation lies in the extensive information available from both solid and liquid propulsion. Author

N91-24250# American Rocket Co., Camarillo, CA.
NON-ACOUSTIC COMBUSTION INSTABILITY IN HYBRID ROCKET MOTORS
D. M. Guthrie and R. S. Wolf *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 177-187 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

A non-acoustic instability (NAI) was encountered during the development of a 75,000 pound thrust hybrid rocket motor. The frequency of oscillation is related to the fill/flush time of the combustion chamber. A correlation for solid rocket motor NAI frequencies is reviewed and compared to hybrid motor results. Several causal mechanisms are postulated and examined experimentally to determine their role in NAI. Inadequate LOx vaporization is identified as the proximate cause of NAI. Methods for enhancing vaporization are discussed and test results presented. The use of splashblocks for suppressing NAI is examined, and minimum required splashblock areas determined. Author

N91-24251*# Aerojet Solid Propulsion Co., Sacramento, CA.
SOLID-LIQUID STAGED COMBUSTION SPACE BOOSTERS
D. W. Culver *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 189-197 (For primary document see N91-24233 16-20)
(Contract NAS8-37775)
Avail: NTIS HC/MF A20 CSCL 21H

NASA has begun to evaluate solid-liquid hybrid propulsion for launch vehicle booster. A three-phase program was outlined to identify, acquire, and demonstrate technology needed to approximate solid and liquid propulsion state of the art. Aerojet has completed a Phase 1 study and recommends a solid-liquid staged combustion concept in which turbopump fed LO2 is burned with fuel-rich solid propellant effluent in aft-mounted thrust chambers.These reasonably sized thrust chambers are LO2 regeneratively cooled, supplemented with fuel-rich barrier cooling. Turbopumps are driven by the resulting GO2 coolant in an expander-bleed-burnoff cycle. Turbine exhaust pressurizes the LO2 tankage directly, and the excess is bled into supersonic nozzle splitlines, where it combusts with the fuel rich boundary layer. Thrust vector control is enhanced by supersonic nozzle movement on flexseal mounts. Every hybrid solid-liquid concept examined improves booster energy management and launch propellant safety compared to current solid boosters. Solid-liquid staged combustion improves hybrid performance by improving both combustion efficiency and combustion stability, especially important for large

boosters. These improvements result from careful fluid management and use of smaller combustors. The study shows NASA safety, reliability, cost, and performance criteria are best met with this concept, wherein simple hardware relies on several separate emerging technologies, all of which have been demonstrated successfully. Author

N91-24252*# Boeing Aerospace Co., Seattle, WA.
DESIGN OPTIMIZATION OF GAS GENERATOR HYBRID PROPULSION BOOSTERS
Vincent Weldon, Dwight Phillips, and Larry Fink *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 199-215 (For primary document see N91-24233 16-20)
(Contract NAS8-37776)
Avail: NTIS HC/MF A20 CSCL 21H

A methodology used in support of a study for NASA/MSFC to optimize the design of gas generator hybrid propulsion booster for uprating the National Space Transportation System (NSTS) is presented. The objective was to compare alternative configurations for this booster approach, optimizing each candidate concept on different bases, in order to develop data for a trade table on which a final decision was based. The methodology is capable of processing a large number of independent and dependent variables, adjusting the overall subsystems characteristics to arrive at a best compromise integrated design to meet various specific optimization criteria subject to selected constraints. For each system considered, a detailed weight statement was generated along with preliminary cost and reliability estimates. Author

N91-24253# American Rocket Co., Camarillo, CA.
A SYSTEM FOR THE TESTING OF HYBRID ROCKET MOTORS
J. S. McFarlane and J. M. Mueller *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 217-223 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

An innovative control and data acquisition system based upon Apple Macintosh technology has been used for several years at American Rocket Company's Edwards Air Force Base test site. The system is based upon the design and display of the test process control and data acquisition diagram on an Apple Macintosh 2 computer screen. All valve positions and important instrumentation points are displayed in real time. Valve actuation is accomplished by on-screen activation of the displayed icon in manual mode or by a computer-controlled automatic schedule. In addition to simplifying the human-machine interface, the system is easily reconfigured. The user can quickly modify the control and data acquisition screen for specific tests. The system is described in detail. The history of testing at the Air Force Astronautics Laboratory utilizing this system is presented. Typical test control diagrams and test results are presented. Author

N91-24254# Aerospace Corp., El Segundo, CA.
SLAG ESTIMATION FOR SOLID ROCKET MOTORS
Scott D. Tingle and Ellis M. Landsbaum *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 225-232 (For primary document see N91-24233 16-20)
(Contract F04701-88-C-0089)
Avail: NTIS HC/MF A20

Slag is estimated in flight motors by comparing flight-delivered performance to performance predicted from static test data. An ideal velocity equation is derived when a linear decrease in specific impulse over burn time and constant flow rate are assumed. The propellant specific impulse is based on static test data and corrected for the effect of slag and spin rate. The ideal velocity is matched to the measured velocity by iterating on the amount of slag. Slag estimations are made for two spin-stabilized PAM-D2's which use Thiokol Star 63D solid motors, and for several spin-stabilized PAM-D flights, which use Thiokol Star 48 solid motors. Author

N91-24255# Air Force Astronautics Lab., Edwards AFB, CA.
A SYSTEM LEVEL ANALYSIS OF THE AMMONIA ARCJET
K. Ennix and W. Pritz *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 233-239 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

The increasing technological maturity of relatively high power electric propulsion devices has led to a renewed interest in their use as a means of efficiently transferring payloads between earth orbits. The move towards such a vehicle requires a solid understanding of system level payoffs and interaction. Using the Electric Vehicle Analyzer (EVA) software tool developed at the Astronautics Laboratory, a systems level study was performed on an ammonia arcjet. The mission design constraints consisted of a Geosynchronous Earth Orbit (GEO) transfer that must be completed within a 200 day trip time. Technological maturity in electric propulsion devices lead to the selection of ammonia-fueled arcjets as the basis for the propulsion system for near term applications. However, the alternatives, methane and hydrogen, are briefly discussed. Another aspect of this study is power and its trip time and payload. Author

N91-24256*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
UPRATED OMS ENGINE STATUS-SEA LEVEL TESTING RESULTS
J. D. Bertolino (Aerojet Solid Propulsion Co., Sacramento, CA.) and W. C. Boyd *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 241-250 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

The current Space Shuttle Orbital Maneuvering Engine (OME) is pressure fed, utilizing storable propellants. Performance uprating of this engine, through the use of a gas generator driven turbopump to increase operating pressure, is being pursued by the NASA Johnson Space Center (JSC). Component level design, fabrication, and test activities for this engine system have been on-going since 1984. More recently, a complete engine designated the Integrated Component Test Bed (ICTB), was tested at sea level conditions by Aerojet. A description of the test hardware and results of the sea level test program are presented. These results, which include the test condition operating envelope and projected performance at altitude conditions, confirm the capability of the selected Uprated OME (UOME) configuration to meet or exceed performance and operational requirements. Engine flexibility, demonstrated through testing at two different operational mixture ratios, along with a summary of projected Space Shuttle performance enhancements using the UOME, are discussed. Planned future activities, including ICTB tests at simulated altitude conditions, and recommendations for further engine development, are also discussed. Author

N91-24257*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED LAUNCH VEHICLE UPPER STAGES USING LIQUID PROPULSION AND METALLIZED PROPELLANTS
Bryan A. Palaszewski *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 251-271 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

Metallized propellants are liquid propellants with a metal additive suspended in a gelled fuel or oxidizer. Typically, aluminum (Al) particles are the metal additive. These propellants provide increase in the density and/or the specific impulse of the propulsion system. Using metallized propellant for volume-and mass-constrained upper stages can deliver modest increases in performance for low earth orbit to geosynchronous earth orbit (LEO-GEO) and other earth orbital transfer missions. Metallized propellants, however, can enable very fast planetary missions with a single-stage upper stage system. Trade studies comparing metallized propellant stage performance with non-metallized upper stages and the Inertial Upper Stage (IUS) are presented. These upper stages are both one- and two-stage vehicles that provide the added energy to send payloads to altitudes and onto trajectories that are

unattainable with only the launch vehicle. The stage designs are controlled by the volume and the mass constraints of the Space Transportation System (STS) and Space Transportation System-Cargo (STS-C) launch vehicles. The influences of the density and specific impulse increases enabled by metallized propellants are examined for a variety of different stage and propellant combinations. Author

N91-24258*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A THREE-DIMENSIONAL TURBULENT HEAT TRANSFER ANALYSIS FOR ADVANCED TUBULAR ROCKET THRUST CHAMBERS

Kenneth J. Kacynski *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 273-279 (For primary document see N91-24233 16-20)

Avail: NTIS HC/MF A20 CSCL 21H

Heat transfer was analyzed in the throat region of a plug and spool rocket engine for both smooth and corrugated walls. A three-dimensional, Navier-Strokes code was used for the analysis. The turbulence model in the code was modified to handle turbulence suppression in the crevice region of the corrugated wall. Circumferential variations in the wall heat transfer was predicted for the corrugated wall. The overall heat transfer at the throat of the corrugated wall was 34 percent higher than it was for the smooth wall for comparable rocket flow conditions.

Author

N91-24259# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.

NONCONTACTING MULTIPARAMETRIC SENSOR FOR SHAFT SPEED, TORQUE, AND POSITION **c35**

A. Schwartzbart *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 281-269 (For primary document see N91-24233 16-20)

Avail: NTIS HC/MF A20

The parameters of greatest interest in bearing diagnostics are shaft torque. Shaft vibration is often monitored as a periodic change in shaft position. Typical bearing diagostic systems require separate sensors for monitoring shaft vibration and shaft torque. If these two parameters can be monitored with one sensor, a reduction in weight intrusion associated with the sensors would result. This would broaden the range of applications and/or facilitate increased redundancy. Accordingly, Rocketdyne has been performing IR and D-funded experiments to find multiparametric characteristics of the shaft-generated signal from a noncontacting torquemeter. The torquemeter already monitors shaft in addition to torque thus providing a measure of shaft power. Presented are the results of recent experimental demonstrations of shaft position measurement capability using the torquemeter in a multiparametric mode.

Author

N91-24260# McDonnell-Douglas Space Systems Co., Huntington Beach, CA.

ORBIT TRANSFER VEHICLE PROPULSION DESIGN: TRADES AND COMPARISONS

V. E. Haloulakos and T. M. Miller *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 291-298 (For primary document see N91-24233 16-20)

(Contract IRAD-PD-189)

Avail: NTIS HC/MF A20

In-space expendable orbital transfer vehicles (OTVs) capable of delivering 36,000 kg (79,366 lb) of payload from earth orbit (LEO) to geosynchronous orbit (GEO) including return missions to LEO both empty and with a retrieved payload were compared and evaluated. Chemical (LOX/LH2), nuclear thermal (NTR), and thermo-nuclear fusion propulsion systems were considered, vehicle mass breakdowns were calculated, and comparisons made. The chemical systems used performance and systems data typical of the RL-10 and J-2 engines while the nuclear systems used the solid-core ALPHA NTR (a NERVA derivative) performance parameters. The fusion propulsion systems represent new designs from a recently conducted study. PC-based computer program was written to automate the vehicle sizing process. The results indicate that the sizing software developed in this study correlates very well with mass property data from actual OTV designs. As expected, the study shows that as the propulsion system performance increases the total vehicle mass required in LEO decreases. A reusable nuclear OTV initial mass in LEO increases only slightly for empty return missions compared to an expendable, one-way trip OTV. The study also shows that fusion systems are limited to lower levels (approximately equal to 100 kN or 22.5 klbf) because of the size of the power generating equipment, and optimize (i.e., minimum initial mass) at a specific impulse of approximately 1000 to 3000 s. Author

N91-24261*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Propulsion and Chemical Systems Section.

LONG-TERM PROPELLANT/MATERIAL COMPATIBILITY **c28**

Clifford M. Moran *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 299-306 (For primary document see N91-24233 16-20)

Avail: NTIS HC/MF A20 CSCL 22I

More than 400 test capsules containing liquid propellants in contact with metallic and nonmetallic specimens are now approaching twenty years in JPL's temperature controlled storage facility. A testing program is being established for the systematic analysis of at least half of those capsules. In addition, the results are reported of about 40 recent analyses. Author

N91-24262# Atlantic Research Corp., Niagara Falls, NY. Liquid Propulsion.

COMPOSITE OVERWRAP POSITIVE EXPULSION PROPELLANT TANKS **c18**

W. A. Sanscrainte and L. K. West (Aerojet TechSystems Co., Sacramento, CA.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 307-315 (For primary document see N91-24233 16-20)

Avail: NTIS HC/MF A20

Design features of the small positive expulsion propellant tanks for the Aerojet System Concepts and Integration Technologies, SCIT, propulsion system are described. The tanks have 2219 aluminum liners, 1100 aluminum diaphragms and carbon fiber/epoxy overwrap. Fabrication includes liner and diaphragm spinning using machined preforms and machined inlet and outlet fittings and tubes. Electronic Beam welding is used to join the metal parts. The composite overwrap includes a hoop wrap at the tank girth and two helical wraps over the liner surfaces. Tank operation is described and tank pressure drop versus percent expelled is given. Center of gravity control, tank weight and acceptance testing are discussed. Development problems and solutions are reviewed. Author

N91-24263*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE COLD-SAT EXPERIMENT FOR CRYOGENIC FLUID MANAGEMENT TECHNOLOGY **c28**

J. R. Schuster, J. P. Wachter (Ford Aerospace and Communications Corp., Palo Alto, CA.), and D. M. Vento *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 317-331 (For primary document see N91-24233 16-20)

(Contract NAS3-25062)

Avail: NTIS HC/MF A20 CSCL 21I

Future national space transportation missions will depend on the use of cryogenic fluid management technology development needs for these missions. In-space testing will be conducted in order to show low gravity cryogenic fluid management concepts and to acquire a technical data base. Liquid H2 is the preferred test fluid due to its propellant use. The design of COLD-SAT (Cryogenic On-orbit Liquid Depot Storage, Acquisition, and Transfer Satellite), an Expendable Launch Vehicle (ELV) launched orbital spacecraft that will perform subcritical liquid H2 storage and transfer experiments under low gravity conditions is studied. An Atlas launch vehicle will place COLD-SAT into a circular orbit, and the 3-axis controlled spacecraft bus will provide electric power, experiment

control, and data management, attitude control, and propulsive accelerations for the experiments. Low levels of acceleration will provide data on the effects that low gravity might have on the heat and mass transfer processes used. The experiment module will contain 3 liquid H2 tanks; fluid transfer, pressurization and venting equipment; and instrumentation. Author

N91-24264# Aerospace Corp., El Segundo, CA.
A LINEARIZED THEORY FOR UNSTEADY FLOW ALONG VANE-FORMED FILLETS DRIVEN BY SURFACE TENSION
c34
James J. Der *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 333-338 (For primary document see N91-24233 16-20)
(Contract F04701-88-C-0089)
Avail: NTIS HC/MF A20

A mathematical model was formulated for the flow through the fillets of liquid propellant formed in the intersections of vanes and tank walls. In addition, based on a small perturbation approximation, first-order linear equations for the surface tension driven flow in zero-g condition were obtained. The resulting equations are useful for predicting an unsteady inviscid flow along the fillets. These equations are analogous to the well known acoustic equation and the linearized potential equation for supersonic flow. The linearized equations show that a small disturbance will travel along the vane at a wave speed equal to the square root of the fraction of the kinematic surface tension coefficient divided by two x the liquid layer thickness h sub 0, i.e., a = (beta/2 h sub 0) sup 1/2, where beta is the surface tension divided by the liquid density. A solution of these equations for a case of a uniform fillet with a small step increase in thickness delta shows that the liquid flows from the thicker portion of the fillet toward the thinner portion at a fraction (delta/h sub 0) of the wave speed. Author

N91-24265# Atlantic Research Corp., Niagara Falls, NY.
STATE-OF-THE-ART 22N (5 lbf) THRUSTER FINDS BROAD APPLICATION
Jacqueline Yager *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 339-347 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

Atlantic Research Corporation's flight qualified 22N (5 lbf) thruster has a proven record of durability, reliability and high performance. It has been selected to provide attitude control and velocity/station keeping on numerous satellite programs. This bipropellant (N2O4/MMH) thruster provides a nominal specific impulse of 291 seconds with a nozzle expansion ratio of 150:1. Predictable and qualified duty cycle independent thermal performance has been demonstrated over an inlet pressure range of 6.6 to 27.6 bar (95 to 400 psia). This performance has been achieved without the use of active cooling by utilizing a unique split triplet injection element. A summary is provided of the engine's development history, its functional characteristics, and its achievements. Author

N91-24266*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Space Materials Science and Engineering Section.
HELIUM SATURATION OF LIQUID PROPELLANTS
A. H. Yavrouian and Clifford M. Moran *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 349-357 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

The research is in three areas which are: (1) techniques were devised for achieving the required levels of helium (He) saturation in liquid propellants (limited to monomethylhydrazine (MMH) and nitrogen tetroxide (NTO)); (2) the values were evaluated for equilibrium solubilities of He in liquid propellants as currently used in the industry; and (3) the He dissolved in liquid propellants were accurately measured. Conclusions drawn from these studies include: (1) Techniques for dissolving He in liquid propellants depending upon the capabilities of the testing facility (Verification of the quantity of gas dissolved is essential); (2) Until greater accuracy is obtained, the equilibrium solubility values of He in MMH and NTO as cited in the Air Force Propellant Handbooks should be accepted as standard (There are still enough uncertainties in the He saturation values to warrant further basic experimental studies); and (3) The manometric measurement of gas volume from a frozen sample of propellant should be the accepted method for gas analysis. Author

N91-24267*# Sandia National Labs., Albuquerque, NM.
CHARACTERIZATION OF IRIDIUM COATED RHENIUM USED IN HIGH-TEMPERATURE, RADIATION-COOLED ROCKET THRUSTERS
R. H. Stulen, D. R. Boehme, W. M. Clift, and K. F. McCarty *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 359-366 (For primary document see N91-24233 16-20)
(Contract NAS3-25646)
Avail: NTIS HC/MF A20 CSCL 21H

Materials used for radiation-cooled rocket thrusters must be capable of surviving under extreme conditions of high-temperatures and oxidizing environments. While combustion efficiency is optimized at high temperatures, many refractory metals are unsuitable for thruster applications due to rapid material loss from the formation of volatile oxides. This process occurs during thruster operation by reaction of the combustion products with the material surface. Aerojet Technical Systems has developed a thruster cone chamber constructed of Re coated with Ir on the inside surface where exposure to the rocket exhaust occurs. Re maintains its structural integrity at high temperature and the Ir coating is applied as an oxidation barrier. Ir also forms volatile oxide species (IrO2 and IrO3) but at a considerably slower rate than Re. In order to understand the performance limits of Ir-coated Re thrusters, we are investigating the interdiffusion and oxidation kinetics of Ir/Re. The formation of iridium and rhenium oxides has been monitored in situ by Raman spectroscopy during high temperature exposure to oxygen. For pure Ir, the growth of oxide films as thin as approximately 200 A could be easily detected and the formation of IrO2 was observed at temperatures as low as 600 C. Ir/Re diffusion test specimens were prepared by magnetron sputtering of Ir on Re substrates. Concentration profiles were determined by sputter Auger depth profiles of the heat treated specimens. Significant interdiffusion was observed at temperatures as low as 1000 C. Measurements of the activation energy suggest that below 1350 C, the dominant diffusion path is along defects, most likely grain boundaries, rather than bulk diffusion through the grains. The phases that form during interdiffusion have been examined by x ray diffraction. Analysis of heated test specimens indicates that the Ir-Re reaction produces a solid solution phase of Ir dissolved in the HCP structure of Re. Author

N91-24268# TRW Space Technology Labs., Redondo Beach, CA.
MONOPROPELLANT HYDRAZINE SPACECRAFT PROPULSION SYSTEMS: 30 YEARS OF SAFE, RELIABLE, FLEXIBLE AND PREDICTABLE PERFORMANCE
David T. Huang and Robert L. Sackheim *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 367-382 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

Monopropellant hydrazine propulsion systems have compiled an enviable record of operational success over the last 30 yr for a large number of spacecraft missions. These missions include near earth, low altitude satellites, geosynchronous orbiting spacecraft, and deep space probed. Many of these flight propulsion systems have demonstrated very long life times (10 to 15 yr) and high mission reliability over a wide range of environmental and operating conditions. However, even with all of the flight success experienced to date, many questions still arise in the spacecraft/user community about the suitability of hydrazine for certain space system applications. The majority of these questions focus on concerns about contamination of highly sensitive optical (mirrors) and thermal control surfaces as well as long total mission life capabilities (with respect to duty cycles, thruster throughput,

total operating times, and total mission times). These concerns are addressed by describing past experiences with specific long-life spacecraft that demonstrate the suitability of hydrazine for use in future highly specialized and sensitive mission applications. Other future concerns are also addressed such as space basing, reusability, and micrometeroid/debris protection. In addition, a short discussion is included on future performance growth possibilities such as the use of hydrazine in dual mode propulsion systems.
Author

N91-24269# Schafer (W. J.) Associates, Inc., Arlington, VA.
SDIO ELECTRIC PROPULSION REQUIREMENTS
Robert J. Vondra and Leonard H. Caveny (Strategic Defense Initiative Organization, Washington, DC.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 383-389 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

Earth-orbit transfer missions, station keeping, and elusive maneuvering benefit from the application of efficient electric propulsion (EP) systems, The Dual Mode of using significant on-board power (i.e., greater than 10 kW) for the main mission coupled to EP for orbit transfer and maneuvering is creating EP opportunities. Hydrogen arcjets at 1400 s rather than the higher specific impulse ion engines are suitable for SDIO orbit transfer missions; the ion engine's low thrust density and expensive fuels work against it. In 1989, research was initiated on hydrogen arcjets (20 to 50 kW, 1000 to 2000 s specific impulse). Research is being conducted to increase the power and thrust density of ion propulsion (10 to 25 kW, 3500 to 4500 s). Space experiments to gain operational experience are being planned around state-of-the-art ammonia arcjets. Research from 1986 to 1989 focused on the ammonia arcjet for the SP-100 flight mission. The thirty kW arcjet's sustained life and inherent simplicity offer low risk and minimum cost for the SP100 flight demonstration objectives. Solar power flight experiments offer near term opportunities for acquiring flying experience on these nearly developed high power arcjet systems. In addition, lower power (approximately 100 W) engines, can meet drag make-up requirements for small, low orbit space systems. Author

N91-24270*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INVESTIGATION OF THE ARCJET NEAR FIELD PLUME USING ELECTROSTATIC PROBES
John M. Sankovic *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 391-406 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

The near field plume of a 1 kW class arcjet thruster was investigated using electrostatic probes of various geometries. The electron number densities and temperatures were determined in a simulated hydrazine plume at axial distances between 3 cm (1.2 in.) and 15 cm (5.9 in.) and radial distances extending to 10 cm (3.9 in.) off centerline. Values of electron number densities obtained using cylindrical and spherical probes of different geometries agreed very well. The electron density on centerline followed a source flow approximation for axial distances as near as 3 cm (1.2 in.) from the nozzle exit plane. The model agreed well with previously obtained data in the far field. The effects of propellant mass flow rate and input power level were also studied. Cylindrical probes were used to obtain ion streamlines by changing the probe orientation with respect to the flow. The effects of electrical configuration on the plasma characteristics of the plume were also investigated by using a segmented anode/nozzle thruster. The results showed that the electrical configuration in the nozzle affected the distribution of electrons in the plume. Author

N91-24271*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ARCJET NOZZLE AREA RATIO EFFECTS
Francis M. Curran, Charles J. Sarmiento, Bjorn W. Birkner, and James Kwasny (Air Force Academy, CO.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 407-416 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 21H

An experimental investigation was conducted to determine the effect of nozzle area ratio on the operating characteristics and performance of a low power dc arcjet thruster. Conical thoriated tungsten nozzle inserts were tested in a modular laboratory arcjet thruster run on hydrogen/nitrogen mixtures simulating the decomposition products of hydrazine. The converging and diverging sides of the inserts had half angles of 30 and 20 degrees, respectively, similar to a flight type unit currently under development. The length of the diverging side was varied to change the area ratio. The nozzle inserts were run over a wide range of specific power. Current, voltage, mass flow rate, and thrust were monitored to provide accurate comparisons between tests. While small differences in performance were observed between the two nozzle inserts, it was determined that for each nozzle insert, arcjet performance improved with increasing nozzle area ratio to the highest area ratio tested and that the losses become very pronounced for area ratios below 50. These trends are somewhat different than those obtained in previous experimental and analytical studies of low Re number nozzles. It appears that arcjet performance can be enhanced via area ratio optimization.
Author

N91-24272# Air Force Astronautics Lab., Edwards AFB, CA.
ANALYSIS OF EXPENDABLE SOLAR ELECTRIC ORBIT TRANSFER VEHICLES
W. M. Schmidt *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 417-421 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

This analysis estimated the payload delivered to geosynchronous (GEO) and one-half GEO orbits from a 430 kilometer, 28.5 degree inclination low earth orbit (LEO). Four propulsion systems were examined based on the 900 second Specific Impulse (Isp) ammonia arcjet, 1500 second Isp hydrogen arcjet, 3000 second Isp ion engine, and 4400 second Isp ion engine. Each of these systems were analyzed at power levels of 10, 20, and 30 kilowatts. Delta 2 and Atlas 2 vehicles were used as launch systems. The results indicated that the 30 kilowatt, ammonia arcjet Orbit Transfer Vehicle (OTV) provided the best compromise between payload capability and trip time. In all cases, this 30 kWe arcjet system increased the payload capability of the launch system by 100 percent with transfer times as low as 99 days over a 444 second Isp chemical OTV. Hydrogen arcjets offered little advantage over ammonia arcjets. Both ion systems yielded payload increases of 200 percent over a 444 second Isp chemical OTV, but required trip times greater than 250 days. This analysis also indicated that power levels below 15 kilowatts resulted in trip times greater than 200 days for most payloads of interest, regardless of the propulsion system. Author

N91-24273# Johns Hopkins Univ., Columbia, MD. Chemical Propulsion Information Agency.
THE 1990 JANNAF PROPULSION MEETING, VOLUME 1
Karen L. Brown, ed. and Debra S. Eggleston, ed. Oct. 1990 458 p Meeting held in Anaheim, CA, 3-5 Oct. 1990
(Contract N00014-91-C-0001)
(CPIA-Publ-550-Vol-1) Avail: NTIS HC/MF A20

This volume, the first of six volumes, is a collection of 34 unclassified/unlimited distribution papers which were presented at the 1990 Joint Army-Navy-NASA-Air Force (JANNAF) Propulsion Meeting, held October 3-5, 1990 in Anaheim, California. Specific subjects discussed include insensitive munitions, composite rocket motor cases, instrumentation, turboramjets, hypersonic airbreathing test facilities, airbreathing combined cycle engines, electric thrusters, and monopropellant systems. For individual titles, see N91-24274 through N91-24298.

N91-24274# Air Force Astronautics Lab., Edwards AFB, CA.
NOZZLE VECTOR ANGLE DETERMINATION USING A LASER MEASUREMENT SYSTEM

W. A. Mascio, J. F. Seely, and R. J. Torick, Jr. (Arnold Engineering Development Center, Arnold Air Force Station, TN.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 33-44 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

The measurements of nozzle position during solid-propellant rocket motor (SRM) ground testing is addressed. The two principal measurement systems currently used to determine nozzle position are a system of linear potentiometers and nozzle actuator feedback systems. These two systems are mounted on the motor and provide outputs which are a function of their displacements. These measurement systems are, however, subjected to motor-and-nozzle-peculiar motions caused by motor pressurization. Linear potentiometer calculations attempt to account for these motor and nozzle movements through appropriate data reduction schemes; actuator feedback systems do not. A laser-based technique was developed with the intent of providing a nonintrusive measurement system, independent of the test article, which would be capable of measuring the nozzle position with respect to the motor centerline regardless of motor-and-nozzle-peculiar motion. The feasibility of the system was demonstrated on rocket motor ground tests at both sea-level and altitude test facilities. The system was demonstrated at ambient, cold, and hot test temperatures. The nozzle material targeted was carbon/carbon composite. Excellent results were obtained to date (the specific laser system hardware used for this demonstration was designed, however, for a different application, and its capabilities were found lacking in the SRM environment). The results were evaluated against data acquired by the current measurement systems. Based upon this evaluation, it is concluded that this technique is feasible, and provides a level of accuracy on the order of the currently recognized standard measurement system (potentiometer-based) while maintaining the advantages of a nonintrusive, ground-based system. Author

N91-24275# Aerojet Solid Propulsion Co., Sacramento, CA.
EVOLUTION OF AN AGING PROGRAM MINUTEMAN STAGE 2 SOLID ROCKET MOTOR
P. W. Veit, L. G. Landuk, J. W. Simpson, and G. J. Svob *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 45-54 (For primary document see N91-24273 16-20)
(Contract F42600-86-D-0093)
Avail: NTIS HC/MF A20

Aging and surveillance programs designed to verify the service life of the propellant-liner-insulation system of the Minuteman Stage 2 and Stage 3 motors have been underway for the past 27 years. During that period, the program has been continuously revised to refocus the effort and to incorporate technology advances. An historical review of the program is presented, with emphasis upon the evolutionary process which led to the current program structure. The 'umbrella approach' to testing applied in the early days is discussed, as is the major impact provided by the ability to 'look at the motor', made possible by the development of motor dissection and nondestructive evaluation techniques. Finally, the present balanced approach incorporating 'the best of both worlds' is addressed, and several important lessons learned during the arduous process of recognizing and correcting early judgment errors are elucidated. Author

N91-24276# Aerojet Solid Propulsion Co., Sacramento, CA.
FLIGHTWEIGHT DIVERT PROPULSION SYSTEM HOT-FIRE TEST
L. K. West and P. C. Phillipsen *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 61-67 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

On June 8, 1990, Aerojet Propulsion division successfully hot-fire tested a flightweight liquid bipropellant propulsion system designed to provide divert delta V to a space-intercept kinetic kill vehicle. The propulsion system verified in this test is directly applicable to SBE, GBI, and Brilliant Pebbles kill vehicles. The subject propulsion system was tested as an autonomous system with four divert thrusters, one each fuel and oxidizer tank, two helium bottles, eight cold gas ACS thrusters, manifolds, and accessory hardware. The hot-fire test demonstrated the following operations in a 30 second duty cycle which accumulated 267 divert engine firings and 1,446 ACS thruster pulses: (1) waterhammer is controlled during system activation; (2) thrust accuracy of divert and ACS thrusters is maintained within +/- ten percent; (3) the system mixture ratio differs from single engine steady state mixture ratio; (4) the feed system remained stable during various rapid divert and ACS thruster firing cycles; and (5) the 90 cc, 9500 psia helium storage is adequate to supply the ACE, Pressurize propellants, and operate bipropellant valves.
Author

N91-24277# United Technologies Corp., San Jose, CA. Chemical Systems Div.
DEVELOPMENT OF THE ORBUS(R) 1 CARBON FIBER/EPOXY MOTOR CASE FOR THE STARS/STARBIRD PROGRAMS
Hugh M. Reynolds and Manjeet Dhillon *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 69-87 (For primary document see N91-24273 16-20)
(Contract PO-23-0957)
Avail: NTIS HC/MF A20

The Strategic Target System (STARS) Program required the development of a high-performance, thrust-vectorable space motor that would provide 25 percent more performance than the existing fixed-nozzle version. One of the key components that enabled the requirement to be met was the high-performance carbon fiber motor case. The design requirements, design approach and analysis, and demonstrated test data are described, along with the manufacturing approach used to develop this motor case. Delivered fiber strength at burst was 715,500 psi. Demonstrated pressure vessel efficiency was 1.85 x 10(exp 6) inches. Author

N91-24278# Army Missile Command, Redstone Arsenal, AL.
JANNAF STANDARDIZATION OF TENSION, COMPRESSION, AND SHEAR TEST METHODS TO DETERMINE MECHANICAL MATERIAL PROPERTIES FOR FILAMENT WOUND COMPOSITE STRUCTURES
Terry L. Vandiver *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 89-102 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

The history and progress to date of efforts to develop standard test techniques for the determination of mechanical material properties of filament wound composite structures is presented. A chronological sequence of events is provided, leading to the selection of the interim test methods, specimen geometry, specimen fixture selection, testing specifications, design of the Round Robin Test (RRT), processing specifications, manufacture of the test specimens, and manufacture of the test fixtures. The nondestructive testing technique used to determine the quality of the specimens, analysis of the nondestructive evaluation data, strain gaging of the specimens, and plans for statistical analysis of the data are also described. Author

N91-24279# Air Force Astronautics Lab., Edwards AFB, CA.
SOLID ROCKET PROPULSION APPLICATIONS FOR ADVANCED POLYMERS
James S. B. Chew and John Rusek *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 103-110 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

The demands to lower the cost and increase the reliability of solid rocket propulsion systems have forced the aerospace industry to investigate new materials and fabrication techniques. The performance specifications for stiffness, strength, and temperature resistance make the process of finding better materials and processes quite challenging. Advanced structural plastics, such as liquid crystalline polymers, may meet these requirements. The suitability of advanced polymers to meet the cost/performance/reliability requirements was investigated.

Components identified for polymer application include motor cases, igniter housings, and nozzles. An overview of progress to date is presented. Author

N91-24280# Naval Ordnance Station, Indian Head, MD.
SOLID ROCKET BOOSTER INTEGRATION WITH THE AQM-37C MISSILE TARGET
F. M. Cumbo *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 111-117 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

The work performed to integrate a solid rocket booster (SRB) with the AQM-37C Missile Target is presented. The SRB performance and interface requirements were derived based on AQM-37C operational requirements. Tradeoffs of propellant and insulation/stress relief system were made to define a quality design that meets system safety and performance requirements. Booster materials and manufacturing processes were carefully selected in an effort to minimize cost. Propellant and igniter characterization tests were performed and rocket motor case test articles manufactured for future testing. Author

N91-24281# Naval Weapons Center, China Lake, CA.
STABILITY TESTING OF FULL SCALE TACTICAL MOTORS
F. S. Blomshield, J. E. Crump, H. B. Mathes, and M. W. Beckstead (Brigham Young Univ., Provo, UT.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 119-134 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

An ongoing program has been investigating linear and nonlinear combustion instability in solid propellant rocket motors, including the development of a systematic database of motor and stability data. Linear aspects of the motor firing and analysis are described. The motors were 5 inches in diameter and 67 inches in length. The majority were loaded with an 88 percent solids reduced smoke AP/HTPB propellant with a nominal burning rate of 0.240 in/sec at 1000 psi. In addition, motors were fired which contain 1 percent 8-micron aluminum oxide, 90-micron aluminum oxide, and 3-micron zirconium carbide as stability additives in place of 1 percent ammonium perchlorate. Motor pressures ranged from 500 to 1500 psi. Various grain geometries were tested. Pressure coupled combustion response measurements were made at the nominal motor operating pressures. Motor performance and stability calculations were made using the Air Force Solid Performance Program (SPP) and the Standard Stability Prediction Program (SSP) for the several motor configurations that were fired. The stability predictions were compared to the data obtained from the motor firings. Author

N91-24282# Naval Weapons Center, China Lake, CA.
NONLINEAR STABILITY TESTING AND PULSING OF FULL SCALE TACTICAL MOTORS
F. S. Blomshield, C. A. Beiter, H. B. Mathes, J. E. Crump, and M. W. Beckstead (Brigham Young Univ., Provo, UT.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 135-150 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

Results are reported of an ongoing effort to develop an improved understanding of linear and nonlinear combustion instability in solid propellant rocket motors. One goal of the program is to develop a systematic database of motor stability data. The nonlinear aspects of the motor firings and analysis are described. Subjects discussed include motor test parameters and methods used for acoustic pulsing of motors. Nonlinear motor response to pulsing, pulse amplitudes, and characteristics of sustained longitudinal chamber pressure oscillations are summarized. Author

N91-24283# United Technologies Corp., San Jose, CA. Chemical Systems Div.
SHEAR STRESS TRANSDUCER CONCEPTS
E. C. Francis, R. E. Thompson, and S. W. Heerema *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 151-160 (For primary document see N91-24273 16-20)
(Contract F04611-87-C-0062)
Avail: NTIS HC/MF A20

The measurement of shear stress in a solid propellant rocket motor can be accomplished by discreet transducers embedded in the propellant-insulation interface. However, shear stress transducers and application techniques have not been generally available; therefore, new shear transducer concepts are being evaluated. Different types of available shear stress transducers are presented, along with laboratory data on stability and sensitivity. The potential usefulness and drawbacks of each type are presented. Author

N91-24284# United Technologies Corp., San Jose, CA. Chemical Systems Div.
NORMAL STRESS TRANSDUCER BEHAVIOR
R. E. Thompson and E. C. Francis *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 161-170 (For primary document see N91-24273 16-20)
(Contract F04611-87-C-0062)
Avail: NTIS HC/MF A20

Structural analysis procedures are routinely used on composite cases and complex geometry propellant grains to predict structural margins. However, these analyses must be experimentally verified in order to instill confidence in their predictions. A program was undertaken to demonstrate the application of stress transducers under real motor conditions and asses their ability to accurately measure the motor response to thermal and pressure-induced loads. Several different types of normal stress transducers were evaluated under conditions of constant stress, slowly changing (low gradient stress), and termination stresses where dramatic changes occur within a small location. A summary is presented of the type of transducers evaluated and their potential suitability to measure solid rocket motor stresses. Author

N91-24285# Hercules, Inc., Radford, VA. Aerospace and Ordnance Group.
PROCESS AND QUALITY IMPROVEMENTS FOR M7 PROPELLANT **c28**
R. A. Gott *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 171-180 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

A modified M7 propellant was processed using the solventless propellant method of manufacture. Significant improvements in overall propellant quality were made by using solventless manufacturing techniques. The improvements included reduced chemical variability by 18 percent, improved dimensional uniformity by 80 percent, and reduction of internal and external voids and defects by 80 percent. Author

N91-24286*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COOLING SYSTEM AND INSULATION CONCEPT FOR A MACH 5 TURBO-RAMJET AIRCRAFT **c05**
S. C. Jones (Lockheed Engineering and Sciences Co., Hampton, VA.) and D. H. Petley *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 191-201 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20 CSCL 01C

A cooling system and insulation concept for a Mach 5 cruise aircraft, using non-cryogenic fuel is presented. Catalytic endothermic reaction of petroleum fuel is used as the heat sink for engine cooling. A secondary closed-loop coolant circuit removes heat from the engine and transfers this heat to the catalytic reactor. Insulation on the engine flow path surfaces reduces the cooling requirements. A high temperature insulation system, which is capable of a surface temperature of 4,000 F, is used for the combustor and nozzle. A complete closed-loop cooling system design is shown in detail. Main features of this system include a fuel preheater, a catalytic fuel reactor, and engine wall cooling panels. A silicone-based liquid polymer, designed for extended

use at 750 F, is used as the coolant. The preheater and reactor design are based on the results of recent experimental work. The cooling panels are designed using a thermal fluid analysis computer program, which was originally developed for the National Aero-Space Plane (NASP). Major components are analyzed structurally as well as thermally and weights are presented.
Author

N91-24287# Fluidyne Engineering Corp., Minneapolis, MN.
A SUMMARY OF EUROPEAN AND JAPANESE HYPERSONIC FACILITY ACTIVITIES **c09**
D. G. DeCoursin *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 203-210 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

The interest in hypersonic vehicles in Europe and Japan has created a need for test facilities. This need is being filled by upgrading old facilities and building new facilities. The facilities are designed for research in hypersonics and for the development of vehicles ranging from commercial transports to aerospace planes. Vehicle development programs include the French Hermes, German Sanger, and Japanese HOPE. It appears that both Europe and Japan have well defined programs for the acquisition of comprehensive hypersonic test capabilities. The status of this activity is presented through a brief description of modifications to existing facilities and of new facilities being planned or designed and constructed. A comparison is made with the major U.S. facilities.
Author

N91-24288*# GT-Devices, Alexandria, VA.
HIGH PRESSURE MACH 10 TO 20 ELECTROTHERMAL HYPERSONIC WIND TUNNEL **c09**
R. L. Burton, F. D. Witherspoon, O. Rizkalla, and W. Chinitz (General Applied Science Labs., Inc., Ronkonkoma, NY.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 211-226 (For primary document see N91-24273 16-20)
(Contract NAS1-18450)
Avail: NTIS HC/MF A20 CSCL 14B

A new technique is described for generating high enthalpy, long pulse flows for testing scramjet combustors at equivalent flight Mach numbers of 10 to 20. The approach derives from high pressure discharge technology developed for electrothermal guns and space thrusters. Cryogenic liquid air is heated with a high power electric discharge (500 MW for a 15 kg/sec test flow rate) in a capillary tube, generating a quasi-steady pressure of up to 6800 atm at 20,000 K. The heated air is mixed with additional cryogenic air and is expanded in a conventional supersonic nozzle to 0.5 to 1 atm at 3000 to 6000 m/sec. Combustion and nozzle expansion test time of approximately 300 m/sec are contemplated. Facility nozzle chemical kinetics calculations show that above Mach 16 increasing concentrations of argon and oxygen replenishment are required to obtain suitable test conditions. Initial experiments on a subscale test rig are described for 0.5 kg/sec and 300 atm pressure.
Author

N91-24289# Wright Research Development Center, Wright-Patterson AFB, OH.
AN EXPERIMENTAL EVALUATION OF COMBUSTOR LINER MATERIALS FOR SOLID FUEL RAMJET TESTING
J. B. Oppelt *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 227-234 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

The investigation determined the survivability and effect on combustion efficiency of several candidate liner materials for ramjet solid fuel screening tests. A liner is necessary both to protect the combustor walls and to reduce heat loss from the combustion chamber. This heat loss can result in incomplete combustion and poor performance. Both a hydrocarbon and a boron fuel were used to compare the liner's effect on the combustion of these fuel types. A finite element heat conduction model constructed prior to testing indicated that the boron nitride (BN) liner would allow nearly the heat loss of stainless steel, and thus, result in poor measured performance compared to a better insulated combustor. The results of the testing show this to be true for the hydrocarbon fuel. Slag deposits on the liner walls from the boron fuel help insulate the liners and reduced their effect on measured performance. A ceramic liner of a boron nitride/aluminum nitride composition (BN/AlN) withstood the thermal environment and insulated well. Measured combustion efficiency was higher for the BN/AlN liner than for DC 93-104, the accepted liner of choice for ramjet testing. This showed that the choice of liner material can affect performance results, and in the case of DC 93-104, indicated care must be taken to use an adequate thickness of insulator.
Author

N91-24290# Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
SHOCK WAVE/BOUNDARY LAYER INTERACTION CONTROL IN A GENERIC HYPERSONIC INLET **c02**
M. E. White, R. E. Lee, B. D. Couch, and P. Galambos (General Dynamics Corp., Fort Worth, TX.) *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 235-246 (For primary document see N91-24273 16-20)
(Contract N00039-89-C-0001)
Avail: NTIS HC/MF A20

A series of tests were performed to investigate and characterize shock wave/boundary layer interactions typical of hypersonic inlets and to develop methods of controlling regions of shock induced separation by energizing the incoming boundary layer through the use of tangential mass addition. A proof-of-concept test program demonstrated shock wave/boundary layer interaction control in a scramjet inlet using tangential mass addition at simulated flight Mach numbers from 3.5 to 5.0. Results are discussed from a generic hypersonic inlet test program in which the effectiveness of tangential mass addition was investigated at Mach numbers of 6.0, 8.0, and 10.0.
Author

N91-24291# Science Applications International Corp., Fort Washington, PA. Fluid Sciences Div.
ADVANCED COMPUTATIONAL MODELS FOR ANALYZING HIGH SPEED PROPULSIVE FLOWFIELDS **c61**
Sanford M. Dash *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 247-283 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

Recently developed 3-D computational models (SCRINT, PARCH, SCHAFT, CRAFT) which analyze high speed propulsive flowfield problems are described. All the models contain generalized thermochemical capabilities and advanced turbulence models, and all integrate the governing equations using implicit/strongly-conservative upwind and/or central difference numerics. The models differ with respect to discretization (finite-difference vs finite-volume), solution formulation (spatial marching parabolized Navier-Stokes (PNS), iterative PNS, time asymptotic full Navier-Stokes (FNS), and time accurate FNS), chemistry coupling (matrix-split/loosely-coupled vs large-matrix/strongly coupled), and geometric/boundary condition flexibility. The hierarchy of propulsive related problems analyzable by these models is described, with specific model formulations found to be most appropriate for specific classes of propulsive flows. Applications to both air-breathing (scramjet/gas-turbine) and rocket propulsive flowfields are described along with thoughts and experiences related to code validation, turbulence modeling, and the development of problem specific, user-friendly codes. Author

N91-24292# Teledyne CAE, Toledo, OH.
MODEL 320-2: A COMPACT ADVANCED UAV TURBOJET **c07**
Eli H. Benstein, Brian Cassem, and Kathy Elliott *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 285-294 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

The Model 320-2 is a 355 lb. thrust, outgrowth/up-rating of

the family of small turbojets. It follows the thrust growth pattern of its predecessor J69 engines: a 40 percent increase is achieved by supercharging the simple centrifugal stage of the basic 320 turbojet with a high pressure ratio transonic axial stage, without change of engine diameter or core flowpath. The turbine was predesigned to allow for the increased work level without excessive efficiency loss. The engine retains the simple/low parts count design of the new family, which leads to very low production cost targets. Thus, for the intended expendable or limited life/reusable applications, a compact, high-performance, high-technology missile or unmanned air vehicle (UAV) powerplant results. The aerodynamic gas path is presented. The origins of the Model 320-2 is outlined, including its subsystems, the source for the down-scaled supercharging axial, and the approach to deletion of an inlet bleed valve at the 7.85:1 pressure ratio of the compressor. Engine test data are presented in comparison to model predictions, and projections are made for future directions for development.

Author

N91-24293# Marquardt Corp., Van Nuys, CA.

THE CRYOJET REVISITED

B. Singh, W. Roberts, and S. Harper *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 295-304 (For primary document see N91-24273 16-20)

Avail: NTIS HC/MF A20

The viability of a cryojet engine is evaluated for high Mach number applications. Cryojet is an advanced thermodynamic cycle that offers high specific impulse (to 5000 seconds), high thrust-to-weight ratio (up to 25:1) and increased Mach number capability (to 5). These advantages are quantified and key design parameters are addressed. The turbine engine operation is inherently limited by compressor inlet and discharge temperatures. Therefore, for a given compressor pressure ratio there is a maximum allowable freestream Mach number. However, cooling the compressor inlet air reduces these temperatures, resulting in increased Mach number capability. The reduced compressor inlet temperature also results in increased airflow and pressure ratio. These performance improvements are derived from the component rematching effects due to precooling. These benefits may be small at low Mach number operation; however, they increase significantly with increasing Mach number. The research was based on cooling the compressor inlet air with high heat sink cryogenic hydrogen fuel. The realization of these benefits has been limited in the past due to heat exchanger technology. The prohibitive heat exchanger size, weight, and pressure losses for practical design have significantly reduced the realizable benefits. However, with the latest heat exchanger design and fabrication technology enhancements, a significant fraction of the ideal improvements resulting from the thermodynamic rematching can be achieved. Various engine cycles were evaluated. The results indicate the feasibility of using cryojets for high Mach number applications. Component designs, configurations, and component integration, however, must be carefully addressed for each design concept.

Author

N91-24294# Air Force Aero Propulsion Lab., Wright-Patterson AFB, OH. Advanced Propulsion Div.

PREMIXED, TURBULENT COMBUSTION OF AXISYMMETRIC SUDDEN EXPANSION FLOWS

S. A. Ahmed and A. S. Nejad *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 305-312 (For primary document see N91-24273 16-20)

Avail: NTIS HC/MF A20

Velocity and low frequency combustor pressure oscillations were measured in a ramjet dump combustor model. The mean and RMS values of the turbulent velocity field were obtained using a two-component laser Doppler velocimeter (LDV) system operating in the backscatter mode. Reacting flow data were obtained for a premixed propane/air, while isothermal results were collected replacing the propane with nitrogen. The velocity data indicated substantial differences between the two cases. Combustor pressure oscillation data were obtained utilizing high frequency dynamic pressure transducers. The intensity and frequency of the oscillations were measured as a function of inlet velocity, combustor length, and equivalence ratio. Results showed that pressure oscillations were controlled by both vortex kinetics in the combustor and acoustic response of the inlet section.

Author

N91-24295# Wright Research Development Center, Wright-Patterson AFB, OH.

THE DEVELOPMENT OF A LIQUID FUELED GAS GENERATOR FOR DUCTED ROCKET RESEARCH

P. L. Buckley and E. Corporan *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 313-320 (For primary document see N91-24273 16-20)

Avail: NTIS HC/MF A20

A liquid fueled gas generator is described which was designed to simulate the effluent produced by a solid propellant hydrocarbon fuel, typical of those used for ducted rocket propulsion, by burning a very fuel-rich mixture of liquid hydrocarbons with gaseous oxygen. The gas generator was built to function as a tool for the development of components of the ramburner portion of the ducted rocket system and to provide a means for studying the thermochemical processes involved in the production of the fuel-rich effluent and its secondary combustion with air in the ramburner. Successful operation was documented at total fuel and oxidizer flow rates through the gas generator of 0.20 kg/sec (0.44 lbs/sec) during direct-connect ducted rocket combustion tests.

Author

N91-24296# Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ.

MOLECULAR STRUCTURE OF LOW TEMPERATURE FORM OF TRIAMINOGUANIDINIUM NITRATE (TAGN) **c28**

A. J. Bracuti *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 331-344 (For primary document see N91-24273 16-20)

Avail: NTIS HC/MF A20

A rigid-body motion study of triaminoguanidinium nitrate (TAGN) was initiated originally in order to determine if nitrate ion libration might be responsible for the accelerated burning rate observed when this salt is formulated into a propellant with a cyclic nitamine. A low temperature polymorph of TAGN was discovered during the course of this rigid-body motion study. Continuation of this study in the lower temperature regimes, however, necessitated understanding the molecular structure of the low temperature form of TAGN. To do this, a single-crystal x-ray diffraction structure determination of the low temperature form was accomplished. The crystal structure was determined including space group, lattice parameters, atomic coordinates and temperature factors, hydrogen bonding, and density.

Author

N91-24297# Naval Ordnance Station, Indian Head, MD.

HEATS OF EXPLOSION, DETONATION AND REACTION PRODUCTS: THEIR ESTIMATION AND RELATION TO THE FIRST LAW OF THERMODYNAMICS **c28**

Edward E. Baroody and Susan T. Peters *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 345-354 (For primary document see N91-24273 16-20)

Avail: NTIS HC/MF A20

A method to calculate heats of explosion (HOEs) is reviewed. Similarly, a method is provided to calculate heats of detonation (HDETs), which can be used to theoretically evaluate explosive performance. This calculation method also gives predictions of the reaction products for energetic materials which are burning or detonating under various conditions. Since experimental energetic materials are often unavailable in quantities sufficient to experimentally determine the HOE, HDET or reaction products, such theoretical procedures can be very useful. Later, when sufficient material can be obtained, the theoretical values can be checked by determining the heat released when the material is burned or detonated in a bomb calorimeter. The thermodynamics operative in the calorimeter and the calculation method are discussed. The use of the calculations to explain variations in

HDETs measured under different conditions is illustrated. Calculated values are presented along with experimental data.
Author

N91-24298# Sandia National Labs., Albuquerque, NM.
LIQUID PROPELLANT INJECTOR/COMBUSTOR TESTS Progress Report **c28**
R. E. Rychnovsky, R. W. Carling, and S. K. Griffiths *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 363-367 Sponsored in part by DOD (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

A liquid propellant injector/compustor (LP I/C) fixture that produces pressure oscillations similar to those observed in liquid propellant gun firings was designed, built, and tested. The oscillations are due to combustion of the LP. Methods to reduce these oscillations are a high priority in the development of an LP gun. Several different methods to reduce or eliminate the oscillations were considered and tested. Experiments were conducted with three liners in the combustion chamber. Two showed little reduction in oscillations, but the third, a flexible liner, eliminated the pressure oscillations. Results of these tests and other oscillation reduction methods are presented. Author

N91-24299# European Space Agency, Paris (France).
FLIGHT EXPERIMENT HARDWARE FOR SOUNDING ROCKET INVESTIGATIONS: MATERIALS SCIENCE AND FLUID SCIENCES
J. Hunt, ed. Feb. 1991 39 p Revised Original contains color illustrations
(ESA-SP-1116-Rev-1; ISBN-92-9092-036-X; ISSN-0379-6566; ETN-91-99116) Copyright Avail: NTIS HC/MF A03

General information on the use of sounding rockets for conducting experiments under reduced gravity conditions is provided. Common features of sounding rockets are discussed. The European Space Agency sponsors the flight of the European experiments in the German TEXUS (German acronym for technological experiments under weightlessness) and the Swedish MASER Materials Science Experiment Rocket) programs. The TEXUS and MASER programs, their sequences of flight events, concepts of the experimental modules, data transmission and telescience, and descriptions of the experiment modules, are presented. A questionnaire for experiment proposals is included.
ESA

N91-24300*# Aerojet-General Corp., Sacramento, CA. Propulsion Div.
SPACE STATION AUXILIARY THRUST CHAMBER TECHNOLOGY Final Report
Philip J. Robinson Jul. 1990 223 p
(Contract NAS3-24398)
(NASA-CR-185296; NAS 1.26:185296; RPT-2210-90-FR; RPT/E0095.68) Avail: NTIS HC/MF A10 CSCL 21H

The objective was to establish a technical data base to support future development of GO2/GH2 flight thrusters for a Space Station Auxiliary Propulsion System. Specific issues of concern were thruster performance and cycle life. To address these issues, NASA funded Aerojet to design, fabricate, and altitude test two 25-lbf GO2/GH2 thrusters. The first thruster was designed to operate at a nominal mixture ratio (O/F) of 4.0 and expansion area ratio (epsilon) of 100:1. It was tested over a range of O/F from 2.0 to 8.0, achieving a range of specific impulse (Isp) from 440 to 310 lbf-sec/lbm. The second thruster was optimized for a nominal O/F of 8.0 at a lower nozzle expansion area ratio, epsilon, of 30:1. This second thruster was tested over an O/F range of 3.0 to 9.5, achieving an Isp range of 416 to 3323 lbf-sec/lbm, respectively. At O/F = 8.0, the Isp was 360 lbf-sec/lbm, as predicted. Author

N91-24301# Office of Naval Research European Office, FPO New York, NY.
STRIP LAMINATE ROCKET MOTOR CASES Military Applications Summary Bulletin
9 Sep. 1989 1 p
(AD-A233454; ONREUR-MASB-46-89) Avail: NTIS HC/MF A01 CSCL 21/8

The strip laminate system of rocket case manufacture is a technique that combines conventional metal technology with advanced laminate bonding. Cases constructed in this manner retain the advantages of metal construction; i.e., high strength, flexural stiffness, and robustness, and add the advantage of reinforced plastics by producing highly accurate tubes and giving freedom from explosion when the rocket motor is subjected to fragment attack or immersion in fire. When subjected to fragment attack or external fire, conventional rocket motors invariably explode with varying degrees of violence. In high density storage and launching systems, the violence of the reaction can compromise the viability of a fighting unit. Such attacks on a strip laminate motor result in extensive delamination of the motor case; thus, a buildup of internal pressure is prevented, reducing the incident from that of explosion to one of fire. A brief description of the manufacturing process is presented in this one page document. GRA

N91-24302*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A DUAL-COOLED HYDROGEN-OXYGEN ROCKET ENGINE HEAT TRANSFER ANALYSIS
Kenneth J. Kacynski, John M. Kazaroff, and Robert S. Jankovsky 1991 17 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-26 Jun. 1991; sponsored by AIAA, SAE, ASME and the American Society for Electrical Engineers
(NASA-TM-104430; E-6186; NAS 1.15:104430; AIAA-91-2211)
Avail: NTIS HC/MF A03 CSCL 21H

The potential benefits of simultaneously using hydrogen and oxygen as rocket engine coolants are described. A plug-and-spool rocket engine was examined at heat fluxes ranging from 9290 to 163,500 kW/sq m, using a combined 3-D conduction/advection analysis. Both counter flow and parallel flow cooling arrangements were analyzed. The results indicate that a significant amount of heat transfer to the oxygen occurs, reducing both the hot side wall temperature of the rocket engine and also reducing the exit temperature of the hydrogen coolant. In all heat flux and coolant flow rates examined, the total amount of heat transferred to the oxygen was found to be largely independent of the oxygen coolant flow direction. At low heat flux/low coolant flow (throttled) conditions, the oxygen coolant absorbed more than 30 percent of the overall heat transfer from the rocket engine exhaust gasses. Also, hot side wall temperatures were judged to decrease by approximately 120 K in the throat area and up to a 170 K combustion chamber wall temperature reduction is expected if dual cooling is applied. The reduction in combustion chamber wall temperatures at throttled conditions is especially desirable since tha analysis indicates that a double temperature maxima, one at the throat and another in the combustion chamber, occurs with a traditional hydrogen cooled only engine. Conversely, a dual cooled engine essentially eliminates any concern for overheating in the combustion chamber. Author

N91-24303*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CARBON MONOXIDE AND OXYGEN COMBUSTION EXPERIMENTS: A DEMONSTRATION OF MARS IN SITU PROPELLANTS
Diane L. Linne 1991 19 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104473; E-6320; NAS 1.15:104473; AIAA-91-2443)
Avail: NTIS HC/MF A03 CSCL 21H

The feasibility of using carbon monoxide and oxygen as rocket propellants was examined both experimentally and theoretically. The steady-state combustion of carbon monoxide and oxygen was demonstrated for the first time in a subscale rocket engine. Measurements of experimental characteristic velocity, vacuum specific impulse, and thrust coefficient efficiency were obtained

over a mixture ratio range of 0.30 to 2.0 and a chamber pressures of 1070 and 530 kPa. The theoretical performance of the propellant combination was studied parametrically over the same mixture ratio range. In addition to one dimensional ideal performance predictions, various performance reduction mechanisms were also modeled, including finite-rate kinetic reactions, two-dimensional divergence effects and viscous boundary layer effects. Author

N91-24304*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LAUNCH VEHICLE PERFORMANCE USING METALLIZED PROPELLANTS
Bryan A. Palaszewski and Richard Powell (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) 1991 16 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104456; E-6297; NAS 1.15:104456; AIAA-91-2050)
Avail: NTIS HC/MF A03 CSCL 21H

Metallized propellant propulsion systems are considered as replacements for the solid rocket boosters and liquid sustainer stages on the current launch vehicles: both the Space Transportation System (STS) and the Titan 4. Liquid rocket boosters for the STS were analyzed as replacements for current solid rocket boosters. These boosters can provide a liquid propulsion system within the volume constraints of a solid rocket booster. A replacement for the Space Shuttle Main Engines using metallized O2/H2/Al was studied. The liquid stages of the Titan 4 were also investigated; the Aerozine-50 (A-50) fuel was replaced with metallized storable A-50/Al. A metallized propellant is similar to a traditional liquid propellant. However, it has metal particles, such as aluminum, that are suspended in a gelled fuel, such as hydrogen, RP-1, A-50 or monomethyl hydrazine (MMH). The fuels then undergo combustion with liquid oxygen or nitrogen tetroxide (NTO). These propellants provide options for increasing the performance of existing launch vehicle chemical propulsion systems by increasing fuel density or specific impulse or both. These increases in density and specific impulse can significantly reduce the propulsion system liftoff weight and allow a liquid rocket booster to fit into the same volume as an existing solid rocket booster. Also, because gelled fuels are akin to liquid propellants, metallized systems can provide enhanced controllability over solid propulsion systems. Gelling of the propellant also reduces the sensitivity to impacts and consequently reduces the propellant explosion hazard. Author

N91-24305*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
IN-SITU PROPELLANT ROCKET ENGINES FOR MARS MISSION ASCENT VEHICLE
Elizabeth A. Roncace 1991 9 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104429; E-6262; NAS 1.15:104429; AIAA-91-2445)
Avail: NTIS HC/MF A02 CSCL 21H

When comtemplating the human exploration of Mars, many scenarios using various propulsion systems have been considered. One propulsion option among them is a vehicle stage with multiple, pump fed rocket engines capable of operating on propellants available on Mars. This reduces the Earth launch mass requirements, resulting in economic and payload benefits. No plentiful sources of hydrogen on Mars have been identified on the surface of Mars, so most commonly used high performance liquid fuels, such as hydrogen and hydrocarbons, can be eliminated as possible in-situ propellants. But 95 pct. of the Martian atmosphere consists of carbon dioxide, which can be converted into carbon monoxide and oxygen. The carbon monoxide oxygen propellant conbination is a candidate for a Martian in-situ propellant rocket engine. The feasibility is analyzed of a pump fed engine cycle using the propellant combination of carbon monoxide and oxygen. Author

N91-24306*# Sverdrup Technology, Inc., Brook Park, OH.
FLOW VISUALIZATION OF A ROCKET INJECTOR SPRAY USING GELLED PROPELLANT SIMULANTS Final Report
James M. Green, Douglas C. Rapp, and James Roncace Cleveland, OH NASA Jun. 1991 18 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(Contract NAS3-25266)
(NASA-CR-187142; E-6276; NAS 1.26:187142; AIAA-91-2198)
Avail: NTIS HC/MF A03 CSCL 21H

A study was conducted at NASA-Lewis to compare the atomization characteristics of gelled and nongelled propellant simulants. A gelled propellant simulant composed of water, sodium hydroxide, and an acrylic acid polymer resin (as the gelling agent) was used to simulate the viscosity of an aluminum/PR-1 metallized fuel gel. Water was used as a comparison fluid to isolate the rheological effects of the water-gel and to simulate nongelled RP-1. The water-gel was injected through the central orifice of a triplet injector element and the central post of a coaxial injector element. Nitrogen gas flowed through the outer orifices of the triplet injector element and through the annulus of the coaxial injector element and atomized the gelled and nongelled liquids. Photographs of the water-gel spray patterns at different operating conditions were compared with images obtained using water and nitrogen. A laser light was used for illumination of the sprays. The results of the testing showed that the water sprays produced a finer and more uniform atomization than the water-gel sprays. Rheological analysis of the water-gel showed poor atomization caused by high viscosity of water-gel delaying the transition to turbulence. Author

N91-24307*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STRUCTURAL INTEGRITY AND DURABILITY OF REUSABLE SPACE PROPULSION SYSTEMS
Apr. 1989 259 p Conference held in Cleveland, OH, 18-19 Apr. 1989
(NASA-CP-10030; E-4628; NAS 1.55:10030) Avail: NTIS HC/MF A12 CSCL 21H

Presentations were made by industry, university, and government researchers organized into four sessions: aerothermodynamic loads; instrumentation; fatigue, fracture, and constitutive modeling; and structural dynamics. For individual titles, see N91-24308 through N91-24338.

N91-24308*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF THE FATIGUE/FRACTURE/LIFE WORKING GROUP PROGRAM AT THE LEWIS RESEARCH CENTER c39
Michael A. McGaw *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 1-3 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

Constitutive and life prediction models are developed and verified for materials typically used in hot gas path components of reusable space propulsion systems over the range of relevant operating environments. The efforts were centered on the development of crack initiation life prediction methods, while the efforts of a counterpart group were centered on the development of cyclic crack propagation life prediction methods. The complexion of the active tasks are presented. A significant new task started this year will incorporate the various material constitutive and life prediction models developed in this program into a comprehensive creep-fatigue damage analysis and life assessment computer code. The program will function as a postprocessor to general structural analysis programs (such as finite element or boundary element codes) using the output of such analyses (stress, strain, and temperature fields as functions of time) as the input to the damage analysis and life assessment code. The code will be designed to execute on engineering/scientific workstations and will feature a windowing, mouse-driven user interface. Current plans call for the code to be finished and made available for use in mid 1991. Author

N91-24309*# Pratt and Whitney Aircraft, East Hartford, CT.
APPLICATION OF CYCLIC DAMAGE ACCUMULATION LIFE PREDICTION MODEL TO HIGH TEMPERATURE COMPONENTS **c39**
Richard S. Nelson *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 5-15 (For primary document see N91-24307 16-20)
(Contract NAS3-23288)
Avail: NTIS HC/MF A12 CSCL 20K

A high temperature, low cycle fatigue life prediction method was developed. This method, Cyclic Damage Accumulation (CDA), was developed for use in predicting the crack initiation lifetime of gas turbine engine materials, but it can be applied to other materials as well. The method is designed to account for the effects on creep-fatigue life of complex loading such as thermomechanical fatigue, hold periods, waveshapes, mean stresses, multiaxiality, cumulative damage, coatings, and environmental attack. Several features of this model were developed to make it practical for application to actual component analysis, such as the ability to handle nonisothermal loading (including TMF), arbitrary cycle paths, and multiple damage modes. The CDA life prediction model was derived from extensive specimen tests conducted on cast nickel-base superalloy B1900 + Hf. These included both monotonic tests (tensile and creep) and strain-controlled fatigue experiments (uniaxial, biaxial, TMF, mixed creep-fatigue, and controlled mean stress). Additional specimen tests were conducted on wrought INCO 718 to verify the applicability of the final CDA model to other high-temperature alloys. The model will be available to potential users in the near future in the form of a FORTRAN-77 computer program. Author

N91-24310*# United Technologies Research Center, East Hartford, CT.
NOTCHED FATIGUE OF SINGLE CRYSTAL PWA 1480 AT TURBINE ATTACHMENT TEMPERATURES **c39**
T. G. Meyer, D. M. Nissley, and G. A. Swanson (Pratt and Whitney Aircraft, East Hartford, CT.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 17-23 (For primary document see N91-24307 16-20)
(Contract NAS3-23939)
Avail: NTIS HC/MF A12 CSCL 20K

The focus is on the lower temperature, uncoated and notched features of gas turbine blades. Constitutive and fatigue life prediction models applicable to these regions are being developed. Fatigue results are presented which were obtained thus far. Fatigue tests are being conducted on PWA 1480 single crystal material using smooth strain controlled specimens and three different notched specimens. Isothermal fatigue tests were conducted at 1200, 1400, and 1600 F. The bulk of the tests were conducted at 1200 F. The strain controlled tests were conducted at 0.4 percent per second strain rate and the notched tests were cycled at 1.0 cycle per second. A clear orientation dependence is observed in the smooth strain controlled fatigue results. The fatigue lifes of the thin, mild notched specimens agree fairly well with this smooth data when elastic stress range is used as a correlating parameter. Finite element analyses were used to calculate notch stresses. Fatigue testing will continue to further explore the trends observed thus far. Constitutive and life prediction models are being developed. Author

N91-24311*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TENSILE AND FATIGUE BEHAVIOR OF TUNGSTEN/COPPER COMPOSITES **c24**
Michael J. Verrilli, Timothy P. Gabb, and Y. S. Kim *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 25-31 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11D

Work on W/Cu unidirectional composites was initiated to study the behavior of this ductile-ductile composite system under thermomechanical fatigue and to examine the applicability of fatigue-life prediction methods for thermomechanical fatigue of this metal matrix composite. The first step was to characterize the tensile behavior of four ply, 10 vol. percent W/Cu plates at room and elevated temperatures. Fatigue tests were conducted in load control on 0 degree specimens at 260 C. The maximum cyclic stress was varied but the minimum cyclic stress was kept constant. All tests were performed in vacuum. The strain at failure increased with increasing maximum cyclic stress. Author

N91-24312*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CUMULATIVE CREEP FATIGUE DAMAGE IN 316 STAINLESS STEEL **c26**
Michael A. McGaw *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 33-37 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11F

The cumulative creep-fatigue damage behavior of 316 stainless steel at 1500 F was experimentally established for the two-level loading cases of fatigue followed by fatigue, creep fatigue followed by fatigue, and fatigue followed by creep fatigue. The two-level loadings were conducted such that the lower life (high strain) cycling was applied first for a controlled number of cycles and the higher life (low strain) cycling was conducted as the second level to failure. The target life levels in this study were 100 cycles to failure for both the fatigue and creep-fatigue lowlife loading, 5000 cycles to failure for the higher life fatigue loading and 10,000 cycles to failure for the higher life creep-fatigue loading. The failed specimens are being examined both fractographically and metallographically to ascertain the nature of the damaging mechanisms that produced failure. Models of creep-fatigue damage accumulation are being evaluated and knowledge of the various damaging mechanisms is necessary to ensure that predictive capability is instilled in the final failure model. Author

N91-24313*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FATIGUE BEHAVIOR OF A SINGLE-CRYSTAL SUPERALLOY **c26**
Sreeramesh Kalluri (Sverdrup Technology, Inc., Cleveland, OH.) and Michael A. McGaw *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 39-44 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11F

A single-crystal superalloy, PWA 1480 is under consideration as a replacement material for the turbine blades of the high pressure fuel turbopump (HPFTP) of the space shuttle main engine (SSME). Three separate experimental programs were conducted to characterize the fatigue behavior of this alloy. Fatigue tests were conducted at room temperature (in air) and at 1000 F (in vacuum) on smooth specimens machined from both cast bars and slabs. The data from all of these programs are consolidated to provide a broader characterization of the fatigue behavior of the single crystal PWA 1480. The zero-mean-stress fatigue relationships are expressed in terms of stress range versus cyclic life lines on log-log plots. Characterization of the fatigue behavior of (001) oriented PWA 1480 single crystal under conditions of tensile mean stress was performed by using the unified approach proposed by Heidmann. In this approach the fatigue life is modified by a mean stress parameter so that a single life relationship can be used to represent both zero and tensile mean stress data. Author

N91-24314*# General Electric Co., Cincinnati, OH. Life Assessment and Methods Technology.
ELEVATED TEMPERATURE CRACK GROWTH **c39**
K. S. Kim and R. H. VanStone *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 45-52 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

Alloy 718 crack growth experiments were conducted to assess

the ability of the selected path-independent (P-I) integrals to describe the elevated temperature crack growth behavior. These tests were performed on single edge notch (SEN) specimens under displacement control with multiple extensometers to monitor the specimen and crack mouth opening displacement (CMOD). The displacements in these tests were sufficiently high to induce bulk cyclic inelastic deformation of the specimen. Under these conditions, the linear elastic fracture mechanics (LEFM) parameter K does not correlate the crack growth data. The experimentally measured displacement gradients at the end of specimen gage length were used as the boundary conditions in elastic-plastic finite element method (FEM) analyses. These analyses were performed with a node release approach using CYANIDE, a GEAE FEM code, which included a gap element which is capable of efficiently simulating crack closure. Excellent correlation was obtained between the experimentally measured and predicted variation of stress and CMOD with crack length and the stress-CMOD loops for Alloy 718 tests conducted at 538 C. This confirmed the accuracy of the FEM crack growth simulation approach. The experimentally measured crack growth rate data correlated well the selected P-I integrals. These investigations have produced significant progress in developing P-I integrals as non-linear fracture mechanics parameters. The results suggest that this methodology has the potential of accurately describing elevated temperature crack growth behavior under the combined influence of thermal cycling and bulk elastic-inelastic deformation states. K.C.D.

N91-24315*# Toledo Univ., OH.
ANALYSIS OF DAMAGE IN MMC COMPONENTS USING AN INTERNAL STATE VARIABLE MODEL **c39**
V. K. Arya *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 53-57 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

A metal-matrix composite (MMC) model was developed which includes the concept of damage evolution. The evolution of damage is assumed to be governed by a Kachanov-type equation. This viscoplastic damage model was implemented in the finite element code, MARC. Both uniaxial (creep) and multiaxial (an internally pressurized thick-walled cylinder) problems were analyzed using this implementation. Some preliminary results are presented which consider monotonic (constant) loadings. The creep curves including damage for four fiber orientations are presented. As expected, the minimum creep occurs when load is applied in a direction parallel to the fibers. The tangential strains at the inner radius of a thick-walled MMC-cylinder for four fiber orientations are shown with damage included. The cylinder exhibits the maximum creep resistance when the fibers are oriented in the circumferential direction, perpendicular to the axis of the cylinder. Time-to-failure for the thick-walled cylinder for the same fiber orientation angles is also shown. As expected, the life of the cylinder can be increased by orientating the fibers in the circumferential direction, perpendicular to the axis of the cylinder. The results, although qualitative, indicate that significant benefits in creep-resistance and service life can be achieved by using MMC materials as structural materials for high-temperature design. K.C.D.

N91-24316*# Carnegie-Mellon Univ., Pittsburgh, PA.
THE EFFECT OF HYDROGEN ON THE DEFORMATION BEHAVIOR OF A SINGLE CRYSTAL NICKEL-BASE SUPERALLOY **c26**
W. S. Walston, A. W. Thompson, and I. M. Bernstein (Illinois Inst. of Tech., Chicago.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 59-66 Sponsored by NASA. Lewis Research Center (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11F

The effect of hydrogen on the tensile deformation behavior of PWA 1480 is presented. Tensile tests were interrupted at different plastic strain levels to observe the development of the dislocation structure. Transmission electron microscopy (TEM) foils were cut perpendicular to the tensile axis to allow the deformation of both phases to be simultaneously observed as well as parallel to zone axes (III) to show the superdislocations on their slip planes. Similar to other nickel-base superalloys, hydrogen was detrimental to the room temperature tensile properties of PWA 1480. There was little effect on strength, however the material was severely embrittled. Even without hydrogen, the elongation-to-failure was only approximately 3 percent. The tensile fracture surface was made up primarily of ductile voids with regions of cleavage fracture. These cleavage facets are the eutectic (gamma') in the microstructure. It was shown by quantitative fractography that hydrogen embrittles the eutectic (gamma') and causes the crack path to seek out and fracture through the eutectic (gamma'). There was two to three times the amount of cleavage on the fracture surface of the hydrogen-charged samples than on the surface of the uncharged samples. The effect of hydrogen can also be seen in the dislocation structure. There is a marked tendency for dislocation trapping in the gamma matrix with and without hydrogen at all plastic strain levels. Without hydrogen there is a high dislocation density in the gamma matrix leading to strain exhaustion in this region and failure through the matrix. The dislocation structure at failure with hydrogen is slightly different. The TEM foils cut parallel to zone axes (III) showed dislocations wrapping around gamma precipitates. Zone axes (001) foils show that there is a lower dislocation density in the gamma matrix which can be linked to the effects of hydrogen on the fracture behavior. The primary activity in the gamma precipitates is in the form of superlattice intrinsic stacking faults (SISFs). These faults have also been reported in other ordered alloys and superalloys. K.C.D.

N91-24317*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
THE INFLUENCE OF ADVANCED PROCESSING ON PWA 1480 **c26**
L. G. Fritzemeier and G. D. Schnittgrund *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 67-79 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11F

High thermal gradient casting of PWA 1480 was evaluated as an avenue for reducing the size of casting porosity. Hot isostatic pressing (HIP) was also employed for the elimination of casting pores. An alternate to the standard PWA 1480 coating plus diffusion bonding aging heat treatment cycle was also evaluated for potential improvements in the properties of interest to the Space Shuttle Main Engine (SSME) application. Microstructural changes associated with the high thermal gradient casting process were quantified by measurement of the size and density of the casting porosity, the amount of retained casting eutectic, and dendrite arm spacings. The results of the advanced processing have shown an improvement in material microstructure due to high thermal gradient casting. Improved homogeneity of PWA 1480 is advantageous in providing an improved solution heat treatment window and, potentially, easier HIP. High thermal gradient casting improves fatigue life by reducing casting pore size. The alternate heat treatment improves the balance of strength and ductility which appears to improve low cycle fatigue life, but with a reduction in short time stress rupture life. Based upon these tests, hot isostatic pressing appears to afford further improvements in cyclic life, though additional evaluation is suggested. Development of the alternate heat treatment is not recommended due to the reduced stress rupture capability and the need to develop a new properties data base. High thermal gradient casting and HIP are recommended for application to single crystal castings. K.C.D.

N91-24318*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF THE INSTRUMENTATION PROGRAM Abstract Only **c35**
William C. Nieberding *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 81-82 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 14B

This program is aimed at developing sensors and measurement systems capable of obtaining the data necessary for the verification

of computational models of the structural behavior, the fatigue life, and the environmental conditions pertinent to advanced reusable space propulsion systems. One of the characteristics of measurement systems needed to verify codes is that the sensors must be nonintrusive or at least minimally intrusive so as not to significantly perturb the conditions being measured. This leads to a heavy emphasis on laser optical techniques and on thin-film sensors. Another characteristic of such instruments is that they must be highly accurate and produce very high spatial and temporal resolution of the parameter being measured. The measurement systems needed generally fall into a number of broad categories. First there are the measurements needed on the surfaces of components such as turbine blades and vanes. Some of the desired parameters are temperature, strain, and heat flux. Another broad category encompasses those measurements needed in the flow environment around these components. Here, the desired results are high resolution maps of such parameters as flow velocity, temperature, density, pressure, and species concentration. The remaining category deals with measurements necessary for monitoring the health of the engine. This category has loomed ever more important since the Challenger disaster. An optical method for determining the characteristics of the plume is presented. Holographic measurement of structural damage is also presented. K.C.D.

N91-24319*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

TWO-DIMENSIONAL HIGH TEMPERATURE STRAIN MEASUREMENT SYSTEM **c39**

Christian T. Lant (Sverdrup Technology, Inc., Cleveland, OH.) and John P. Barranger *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 83-86 (For primary document see N91-24307 16-20)

Avail: NTIS HC/MF A12 CSCL 20K

Two-dimensional optical strain measurements on high temperature test specimens are presented. This two-dimensional capability is implemented through a rotatable sensitive strain axis. Three components of surface strain can be measured automatically, from which the first and second principal strains are calculated. One- and two-dimensional strain measurements at temperatures beyond 750 C with a resolution of 15 microstrain are demonstrated. The system is based on a one-dimensional speckle shift technique. The speckle shift technique makes use of the linear relationship between surface strain and the differential shift of laser speckle patterns in the diffraction plane. Laser speckle is a phase effect that occurs when spatially coherent light interacts with an optically rough surface. Since speckle is generated by any diffusely reflecting surface, no specimen preparation is needed to obtain a good signal. Testing was done at room temperature on a flat specimen of Inconel 600 mounted in a fatigue testing machine. A load cell measured the stress on the specimen before and after acquiring the speckle data. Strain components were measured at 0 C (parallel to the load axis) and at plus or minus 45 C, and plots indicate the calculated values of the first and second principal strains. The measured values of Young's modulus and Poisson's ratio are in good agreement with handbook values. Good linearity of the principal strain moduli at high temperatures indicate precision and stability of the system. However, a systematic error in the high-temperature test setup introduced a scale factor in the slopes of the two-dimensional stress-strain curves. No high temperature effects, however, have been observed to degrade speckle correlation. K.C.D.

N91-24320*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

OPTICAL INSPECTION OF SPACE-PROPULSION COMPONENTS USING AN INJECTION SEEDED Nd:YAG LASER SYSTEM **c36**

Arthur J. Decker *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 87-98 (For primary document see N91-24307 16-20)

Avail: NTIS HC/MF A12 CSCL 20E

A dual-beam, injection-seeded, Nd:YAG laser has been demonstrated for detecting structural defects. This demonstration was part of an on-going project to use dual-reference-beam holographic interferometry to inspect space propulsion components for cracks, structural failures, structural changes, and gas leaks. Potential subjects for inspection include welds, duct work, casings, turbopumps, blades, composites, and ceramics. The maximum dimension of an inspected area ranges from a few centimeters to a meter. The entire optical inspection system is now ready for a demonstration application. Author

N91-24321*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CALIBRATOR TESTS OF HEAT FLUX GAUGES MOUNTED IN SSME BLADES **c35**

Curt H. Liebert *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 99-104 (For primary document see N91-24307 16-20)

Avail: NTIS HC/MF A12 CSCL 14B

Measurements of heat flux to space shuttle main engine (SSME) turbine blade surfaces are being made in the Lewis heat flux calibration facility. Surface heat flux information is obtained from transient temperature measurements taken at points within the gauge. A 100-kW Vortek arc lamp is used as a source of thermal radiant energy. Thermoplugs, with diameters of about 0.190 cm and lengths varying from about 0.190 to 0.320 cm, are being investigated. The thermoplug is surrounded on all surfaces except the active surface by a pocket of air located in the circular annulus and under the back cover. Since the thermoplug is insulated, it is assumed that heat is conducted in a one-dimensional manner from the hot active surface to the cooler back side of the thermoplug. It is concluded that the miniature plug-type gauge concept is feasible for measurement of blade surface heat flux. It is suggested that it is important to measure heat flux near the hub on the suction surface and at the throat on SSME blades rotating in engines because stress and heat transfer coefficients are high in this region. Author

N91-24322*# Physical Research, Inc., Torrance, CA.

DEVELOPMENT OF FIBER-BASED LASER ANEMOMETER FOR SSME APPLICATION **c35**

Dariush Modarress and Robert Fan *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 105-112 (For primary document see N91-24307 16-20)

Avail: NTIS HC/MF A12 CSCL 14B

A recent study by Rocketdyne for NASA identified laser anemometry, using a compact optical head, as a feasible diagnostic instrument for the Space Shuttle Main Engine (SSME) Model Verification experiments. Physical Research, Inc. (PRI) is presently under contract from NASA Lewis to develop and deliver such a laser anemometer system. For this application, it is desired to place the laser at a remote distance from the engine, and use single mode polarization preserving fiber optics for the transmission of the laser light to and from the measurement head. Other requirements are given. Analytical and experimental tools are being used to develop the technologies required for the laser anemometer. These include finite element analysis of the optical head and vibration tests for various optical and mechanical components. Design of the optical head and the fiber optic connectors are driven by the temperature and vibration requirements for the measurement environment. Results of the finite element analysis and the vibration tests of the components are included. Conceptual design of the fiber optic launcher and the optical probe has also been complete. Detailed design of the probe as well as the fabrication and assembly of the components is in progress. Author

N91-24323*# Case Western Reserve Univ., Cleveland, OH. Dept. of Mechanical Engineering.

ANALYSIS OF THE TRANSIENT CALIBRATION OF HEAT FLUX SENSORS: ONE DIMENSIONAL CASE **c35**

A. Dybbs and J. X. Ling *In its* Structural Integrity and Durability

of Reusable Space Propulsion Systems Apr. 1989 p 113-122 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 14B

The effect of transient heat flux on heat flux sensor response and calibration is analyzed. A one dimensional case was studied in order to elucidate the key parameters and trends for the problem. It has the added advantage that the solutions to the governing equations can be obtained by analytic means. The analytical results obtained to date indicate that the transient response of a heat flux sensor depends on the thermal boundary conditions, the geometry and the thermal properties of the sensor. In particular it was shown that if the thermal diffusivity of the sensor is small, then the transient behavior must be taken into account. Author

N91-24324*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THIN-FILM SENSORS FOR SPACE PROPULSION TECHNOLOGY: FABRICATION AND PREPARATION FOR TESTING
Walter S. Kim and Aloysius F. Hepp *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 123-126 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 21H

The goal of this work is to develop and test thin-film thermocouples for Space Shuttle Main Engine (SSME) components. Thin-film thermocouples have been developed for aircraft gas turbine engines and are in use for temperature measurement on turbine blades up to 1800 F. Established aircraft engine gas turbine technology is currently being adapted to turbine engine blade materials and the environment encountered in the SSME, especially severe thermal shock from cryogenic fuel to combustion temperatures. Initial results using coupons of MAR M-246 (+Hf) and PWA 1480 have been followed by fabrication of thin-film thermocouples on SSME turbine blades. Current efforts are focused on preparing for testing in the Turbine Blade Tester at the NASA Marshall Space Flight Center (MSFC). Future work will include testing of thin-film thermocouples on SSME blades of single crystal PWA 1480 at MSFC. Author

N91-24325*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ROCKET PLUME SPECTROMETRY: A SYSTEM PERMITTING ENGINE CONDITION MONITORING, AS APPLIED TO THE TECHNOLOGY TEST BED ENGINE
W. T. Powers *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 127-135 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 21H

The appearance of visible objects in the exhaust plume of space shuttle main engines (SSME) during test firings is discussed. A program was undertaken to attempt to identify anomalous material resulting from wear, normal or excessive, of internal parts, allowing time monitoring of engine condition or detection of failure precursors. Measurements were taken during test firings at Stennis Space Center and at the Santa Suzanna facility in California. The results indicated that a system having high spectral resolution, a fast time response, and a wide spectral range was required to meet all requirements, thus two special systems have been designed and built. One is the Optical Plume Anomaly Detector (OPAD). The other instrument, which is described in this report, is the superspectrometer, an optical multichannel analyzer having 8,192 channels covering the spectral band 250 to 1,000 nm.
Author

N91-24326*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROBABILISTIC STRUCTURAL ANALYSIS: INTRODUCTORY REMARKS Abstract Only **c39**
Christos C. Chamis *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 137-138 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

The development of probabilistic structural analysis methodology consists of the following program elements: (1) composite load spectra models, (2) computational probabilistic structural analysis methods, and (3) probabilistic constitutive relationships. The development of the probabilistic structural analysis methodology is a joint program of NASA Lewis in-house and sponsored research. The objective of this session is to illustrate recent progress on the application of this methodology to determine the reliability of structural components for rocket propulsion systems. The session contains descriptions of and progress reports on the following specific activities: (1) The NESSUS computer code, (2) approximate methods, (3) advanced methods, (4) composite load spectra applications, (5) probabilistic fracture mechanisms, and (6) probability of failure and risk analysis. Collectively, the progress to date demonstrates that the structural durability of hot engine structural components can be effectively evaluated in a formal probabilistic/reliability framework. Author

N91-24327*# Southwest Research Inst., San Antonio, TX.
PROBABILISTIC STRUCTURAL ANALYSIS METHODS FOR SELECT SPACE PROPULSION SYSTEM COMPONENTS **c39**
H. R. Millwater and T. A. Cruse *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 139-144 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

The Probabilistic Structural Analysis Methods (PSAM) project developed at the Southwest Research Institute integrates state-of-the-art structural analysis techniques with probability theory for the design and analysis of complex large-scale engineering structures. An advanced efficient software system (NESSUS) capable of performing complex probabilistic analysis has been developed. NESSUS contains a number of software components to perform probabilistic analysis of structures. These components include: an expert system, a probabilistic finite element code, a probabilistic boundary element code and a fast probability integrator. The NESSUS software system is shown. An expert system is included to capture and utilize PSAM knowledge and experience. NESSUS/EXPERT is an interactive menu-driven expert system that provides information to assist in the use of the probabilistic finite element code NESSUS/FEM and the fast probability integrator (FPI). The expert system menu structure is summarized. The NESSUS system contains a state-of-the-art nonlinear probabilistic finite element code, NESSUS/FEM, to determine the structural response and sensitivities. A broad range of analysis capabilities and an extensive element library is present. Author

N91-24328*# Southwest Research Inst., San Antonio, TX.
AN APPROXIMATE METHODS APPROACH TO PROBABILISTIC STRUCTURAL ANALYSIS **c39**
R. C. McClung, H. R. Millwater, Y.-T. Wu, B. H. Thacker, and O. H. Burnside *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 145-151 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

A major research and technology program in Probabilistic Structural Analysis Methods (PSAM) is currently being sponsored by the NASA Lewis Research Center with Southwest Research Institute as the prime contractor. This program is motivated by the need to accurately predict structural response in an environment where the loadings, the material properties, and even the structure may be considered random. The heart of PSAM is a software package which combines advanced structural analysis codes with a fast probability integration (FPI) algorithm for the efficient calculation of stochastic structural response. The basic idea of PAAM is simple: make an approximate calculation of system response, including calculation of the associated probabilities, with minimal computation time and cost, based on a simplified representation of the geometry, loads, and material. The deterministic solution resulting should give a reasonable and realistic description of performance-limiting system responses, although some error will be inevitable. If the simple model has

correctly captured the basic mechanics of the system, however, including the proper functional dependence of stress, frequency, etc. on design parameters, then the response sensitivities calculated may be of significantly higher accuracy. Author

N91-24329*# Southwest Research Inst., San Antonio, TX.
PROBABILISTIC BOUNDARY ELEMENT METHOD **c39**
T. A. Cruse and S. T. Raveendra *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 153-158 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

The purpose of the Probabilistic Structural Analysis Method (PSAM) project is to develop structural analysis capabilities for the design analysis of advanced space propulsion system hardware. The boundary element method (BEM) is used as the basis of the Probabilistic Advanced Analysis Methods (PADAM) which is discussed. The probabilistic BEM code (PBEM) is used to obtain the structural response and sensitivity results to a set of random variables. As such, PBEM performs analogous to other structural analysis codes such as finite elements in the PSAM system. For linear problems, unlike the finite element method (FEM), the BEM governing equations are written at the boundary of the body only, thus, the method eliminates the need to model the volume of the body. However, for general body force problems, a direct condensation of the governing equations to the boundary of the body is not possible and therefore volume modeling is generally required. Author

N91-24330*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
COMPOSITE LOAD SPECTRA FOR SELECT SPACE PROPULSION STRUCTURAL COMPONENTS **c39**
H. Ho, J. F. Newell, and R. E. Kurth (Battelle Columbus Labs., OH.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 159-166 (For primary document see N91-24307 16-20)
(Contract NAS3-24382)
Avail: NTIS HC/MF A12 CSCL 20K

The objective of the Composite Load Spectra (CLS) project is to build a knowledge based system to synthesize probabilistic loads for selected space propulsion engine components. The knowledge based system has a load expert system module and a load calculation module. The load expert system provides load information and the load calculation module generates the probabilistic load distributions. The engine loads are divided into 4 broad classes: the engine independent loads, the engine system dependent load, the component local independent loads and the component loads. These classes are defined and illustrated. Author

N91-24331*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
PROBABILISTIC DESIGN ANALYSIS USING COMPOSITE LOADS SPECTRA (CLS) COUPLED WITH PROBABILISTIC STRUCTURAL ANALYSIS METHODOLOGIES (PSAM) **c39**
J. F. Newell, K. R. Rajagopal, and H. Ho *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 167-180 (For primary document see N91-24307 16-20)
(Contract NAS3-24382)
Avail: NTIS HC/MF A12 CSCL 20K

Composite loads spectra (CLS) were applied to generate probabilistic loads for use in the PSAM nonlinear evaluation of stochastic structures under stress (NESSUS) finite element code. The CLS approach allows for quantifying loads as mean values and distributions around a central value rather than maximum or enveloped values typically used in deterministic analysis. NESSUS uses these loads to determine mean and perturbation responses. These results are probabilistically evaluated with the distributional information from CLS using a fast probabilistic integration (FPI) technique to define response distributions. The main example discussed describes a method of obtaining load descriptions and stress response of the second-stage turbine blade of the Space Shuttle Main Engine (SSME) high-pressure fuel turbopump (HPFTP). Additional information is presented on the on-going analysis of the high pressure oxidizer turbopump discharge duct (HPOTP) where probabilistic dynamic loads have been generated and are in the process of being used for dynamic analysis. Example comparisons of load analysis and engine data are furnished for partial verification and/or justification for the methodology. Author

N91-24332*# Northwestern Univ., Evanston, IL. Dept. of Mechanical Engineering.
PROBABILISTIC FINITE ELEMENTS FOR FRACTURE AND FATIGUE ANALYSIS **c39**
W. K. Liu, T. Belytschko, M. Lawrence, and G. H. Besterfield *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 181-195 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

The fusion of the probabilistic finite element method (PFEM) and reliability analysis for probabilistic fracture mechanics (PFM) is presented. A comprehensive method for determining the probability of fatigue failure for curved crack growth was developed. The criterion for failure or performance function is stated as: the fatigue life of a component must exceed the service life of the component; otherwise failure will occur. An enriched element that has the near-crack-tip singular strain field embedded in the element is used to formulate the equilibrium equation and solve for the stress intensity factors at the crack-tip. Performance and accuracy of the method is demonstrated on a classical mode 1 fatigue problem. Author

N91-24333*# Sverdrup Technology, Inc., Cleveland, OH.
PROBABILITY OF FAILURE AND RISK ASSESSMENT OF PROPULSION STRUCTURAL COMPONENTS **c39**
Michael C. Shiao *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 197-208 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

The probabilistic structural analysis method (PSAM) was developed to analyze the effects of fluctuating loads, variable material properties, and uncertain analytical models especially for high performance structures such as the Space Shuttle Main Engine turbopump blades. Risk is calculated after expensive service experience. However, probabilistic structural analysis provides a rational alternative method to quantify uncertainties in the structural performance and durability. NESSUS (Numerical Evaluation of Stochastic Structures Under Stress) was developed as a probabilistic structural analysis computer code which integrates finite element methods and reliability algorithms, capable to predicting the probability distributions of structural response variables such as stress, displacement, natural frequencies, and buckling loads. This computer code is detailed. Author

N91-24334*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF AEROTHERMODYNAMIC LOADS DEFINITION STUDY **c39**
Raymond E. Gaugler *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 209-214 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

Over the years, NASA has been conducting the Advanced Earth-to-Orbit (AETO) Propulsion Technology Program to provide the knowledge, understanding, and design methodology that will allow the development of advanced Earth-to-orbit propulsion systems with high performance, extended service life, automated operations, and diagnostics for in-flight health monitoring. The objective of the Aerothermodynamic Loads Definition Study is to develop methods to more accurately predict the operating environment in AETO propulsion systems, such as the Space Shuttle Main Engine (SSME) powerhead. The approach taken

consists of 2 parts: to modify, apply, and disseminate existing computational fluid dynamics tools in response to current needs and to develop new technology that will enable more accurate computation of the time averaged and unsteady aerothermodynamic loads in the SSME powerhead. The software tools are detailed. Significant progress was made in the area of turbomachinery, where there is an overlap between the AETO efforts and research in the aeronautical gas turbine field. Author

N91-24335*# Calspan-Buffalo Univ. Research Center, NY.
HEAT-TRANSFER AND SURFACE-PRESSURE MEASUREMENTS FOR THE SSME FUEL-SIDE TURBOPUMP TURBINE **c37**
Michael G. Dunn *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 215-222 (For primary document see N91-24307 16-20)
(Grant NAG3-581)
Avail: NTIS HC/MF A12 CSCL 13I

Detailed heat flux and surface pressure distribution on the first-stage vane and blade of the Space Shuttle Main Engine fuel side turbopump turbine are examined. The specific turbine being utilized for the study is a combination of actual engine hardware and reproduced hardware consistent with that being used at NASA-Marshall for the initial measurements in their newly constructed blow-down turbine test facility. The facility is of the short duration shock tunnel variety, which permits use of thin film thermometers which are used to measure the surface temperature histories at prescribed locations on the turbine component parts. Heat flux values are then inferred from the temperature histories using standard data reduction procedures. The measurement program is described in detail. Author

N91-24336*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
A NEW FACILITY TO STUDY THREE DIMENSIONAL VISCOUS FLOW AND ROTOR-STATOR INTERACTION IN TURBINES Progress Report **c34**
B. Lakshminarayana, C. Camci, and I. Halliwell (General Electric Co., Cincinnati, OH.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 223-236 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20D

A description of the Axial Flow Turbine Research Facility (AFTRF) being built at the Turbomachinery Laboratory of the Pennsylvania State University is presented. The purpose of the research to be performed in this facility is to obtain a better understanding of the rotor/stator interaction, three dimensional viscous flow field in nozzle and rotor blade passages, spanwise mixing and losses in these blade rows, transport of wake through rotor passage, and unsteady aerodynamics and heat transfer of rotor blade row. The experimental results will directly feed and support the analytical and the computational tool development. This large scale low speed facility is heavily instrumented with pressure and temperature probes and has provision for flow visualization and laser Doppler anemometer measurement. The facility design permits extensive use of the high frequency response instrumentation on the stationary vanes and more importantly on the rotating blades. Furthermore it facilitates detailed nozzle wake, rotor wake, and boundary layer surveys. The large size of the rig also has the advantage of operating at Reynolds numbers representative of the engine environment. Author

N91-24337*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN UNCONDITIONALLY STABLE RUNGE-KUTTA METHOD FOR UNSTEADY ROTOR-STATOR INTERACTION **c34**
Rodrick V. Chima and Philip C. E. Jorgenson *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 237-246 Previously announced in IAA as A89-25180 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20D

A quasi-three-dimensional analysis has been developed for unsteady rotor-stator interaction in turbomachinery. The analysis solves the unsteady Euler or thin-layer Navier-Stokes equations in a body-fitted coordinate system. It accounts for the effects of rotation, radius change, and stress-surface thickness. The Baldwin-Lomax eddy-viscosity model is used for turbulent flows. The equations are integrated in time using an explicit four-stage Runge-Kutta scheme with a constant time step. Implicit residual smoothing is used to increase the stability limit of the time-accurate computations. The scheme is described, and stability and accuracy analyses are given. Author

N91-24338*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AVERAGE-PASSAGE FLOW MODEL DEVELOPMENT **c34**
John J. Adamczyk, Mark L. Celestina, Tim A. Beach, Kevin Kirtley, and Mark Barnett (United Technologies Research Center, East Hartford, CT.) *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 247-251 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20D

A 3-D model was developed for simulating multistage turbomachinery flows using supercomputers. This average passage flow model described the time averaged flow field within a typical passage of a bladed wheel within a multistage configuration. To date, a number of inviscid simulations were executed to assess the resolution capabilities of the model. Recently, the viscous terms associated with the average passage model were incorporated into the inviscid computer code along with an algebraic turbulence model. A simulation of a stage-and-one-half, low speed turbine was executed. The results of this simulation, including a comparison with experimental data, is discussed. Author

N91-24339*# Pratt and Whitney Aircraft, West Palm Beach, FL.
ADVANCED LAUNCH SYSTEM ADVANCED DEVELOPMENT OXIDIZER TURBOPUMP PROGRAM: TECHNICAL IMPLEMENTATION PLAN
F. Ferlita 23 Jun. 1989 86 p
(Contract NAS8-37595)
(NASA-CR-183729; NAS 1.26:183729; PWA-FR-20865) Avail: NTIS HC/MF A05 CSCL 21H

The Advanced Launch Systems (ALS) Advanced Development Oxidizer Turbopump Program has designed, fabricated and demonstrated a low cost, highly reliable oxidizer turbopump for the Space Transportation Engine that minimizes the recurring cost for the ALS engines. Pratt and Whitney's (P and W's) plan for integrating the analyses, testing, fabrication, and other program efforts is addressed. This plan offers a comprehensive description of the total effort required to design, fabricate, and test the ALS oxidizer turbopump. The proposed ALS oxidizer turbopump reduces turbopump costs over current designs by taking advantage of design simplicity and state-of-the-art materials and producibility features without compromising system reliability. This is accomplished by selecting turbopump operating conditions that are within known successful operating regions and by using proven manufacturing techniques. Author

N91-24340*# Pratt and Whitney Aircraft, West Palm Beach, FL.
LARGE LIQUID ROCKET ENGINE TRANSIENT PERFORMANCE SIMULATION SYSTEM Report No. 6, 1 Oct. 1988 - 31 May 1989
J. R. Mason and R. D. Southwick 25 Jul. 1989 167 p
(Contract NAS8-36994)
(NASA-CR-188582; NAS 1.26:188582; FR-20282-3) Avail: NTIS HC/MF A08 CSCL 21H

Phase 1 of the Rocket Engine Transient Simulation (ROCETS) program consists of seven technical tasks: architecture; system requirements; component and submodel requirements; submodel implementation; component implementation; submodel testing and verification; and subsystem testing and verification. These tasks were completed. Phase 2 of ROCETS consists of two technical tasks: Technology Test Bed Engine (TTBE) model data generation; and system testing verification. During this period specific coding

of the system processors was begun and the engineering representations of Phase 1 were expanded to produce a simple model of the TTBE. As the code was completed, some minor modifications to the system architecture centering on the global variable common, GLOBVAR, were necessary to increase processor efficiency. The engineering modules completed during Phase 2 are listed: INJTOO - main injector; MCHBOO - main chamber; NOZLOO - nozzle thrust calculations; PBRNOO - preburner; PIPE02 - compressible flow without inertia; PUMPOO - polytropic pump; ROTROO - rotor torque balance/speed derivative; and TURBOO - turbine. Detailed documentation of these modules is in the Appendix. In addition to the engineering modules, several submodules were also completed. These submodules include combustion properties, component performance characteristics (maps), and specific utilities. Specific coding was begun on the system configuration processor. All functions necessary for multiple module operation were completed but the SOLVER implementation is still under development. This system, the Verification Checkout Facility (VCF) allows interactive comparison of module results to store data as well as provides an intermediate checkout of the processor code. After validation using the VCF, the engineering modules and submodules were used to build a simple TTBE.

Author

23 CHEMISTRY AND MATERIALS (GENERAL)

N91-24341*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DETERMINATION OF ALLOY CONTENT FROM PLUME SPECTRAL MEASUREMENTS

George C. Madzsar 1991 15 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers

(NASA-TM-104442; E-6280; NAS 1.15:104442; AIAA-91-2531)

Avail: NTIS HC/MF A03 CSCL 07A

The mathematical derivation for a method to determine the identities and amounts of alloys present in a flame where numerous alloys may be present is described. This method is applicable if the total number of elemental species from all alloys that may be in the flame is greater than or equal to the total number of alloys. Arranging the atomic spectral line emission equations for the elemental species as a series of simultaneous equations enables solution for identity and amount of the alloy present in the flame. This technique is intended for identification and quantification of alloy content in the plume of a rocket engine. Spectroscopic measurements reveal the atomic species entrained in the plume. Identification of eroding alloys may lead to the identification of the eroding component. Author

24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

For ceramic materials see *27 Nonmetallic Materials.*

N91-24342 Missouri Univ., Columbia.

MICROSTRUCTURAL EFFECTS ON THE RESIDUAL STRESS AND STRESS DISTRIBUTION IN WC-NI COMPOSITES Ph.D. Thesis

Kyeongwon Seol 1990 204 p

Avail: Univ. Microfilms Order No. DA9100235

Effects of microstructure on the differential thermal residual stresses and their distributions for model WC-Ni cemented carbide composites were determined by neutron powder diffraction. Absolute strain and stress values were obtained from the difference in WC cell parameters in a stress-free, loose WC powder and the WC phase in the composite over the temperature range 100 to 900 K. The resultant volume averaged strains in the hexagonal WC particles were highly anisotropic, with the strains in the a-direction exceeding those in the c-direction. This was correctly predicted by Eshelby's equivalent inclusion method assuming the particle shape as an oblate spheroid. In addition, the strain distribution in the WC and Ni binder phases were determined by a modified integral peak breadth method of particle size-strain analysis using the peak breadths in the reference powder and the composite. Strain distribution cannot be converted into stress distribution directly because the stresses due to the WC particle aspect ratio are not hydrostatic and because the fraction of each effect on the total strain distribution is not known. Therefore, quantitative stress distribution values were not determined.

Dissert. Abstr.

N91-24343*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MECHANICAL PROPERTY CHARACTERIZATION AND IMPACT RESISTANCE OF SELECTED GRAPHITE/PEEK COMPOSITE MATERIALS

Donald J. Baker (Army Aviation Systems Command, Hampton, VA.) Apr. 1991 30 p Presented at the National Technical Specialists Meeting on Advanced Rotorcraft Structures, Williamsburg, VA, 25-27 Oct. 1988

(NASA-TM-102769; NAS 1.15:102769; AVSCOM-TR-90-B-012)

Avail: NTIS HC/MF A03 CSCL 11D

To use graphite/PEEK material on highly curved surfaces requires that the material be drapable and easily conformable to the surface. The mechanical property characterization and impact resistance results are presented for laminates made from two types of graphite/PEEK materials that will conform to a curved surface. These laminates were made from two different material forms. These forms are: (1) a fabric where each yarn is a co-mingled Celion G30-500 3K graphite fiber and PEEK fiber; and (2) an interleaved material of Celion G30-500 3K graphite fiber interleaved with PEEK film. The experimental results from the fabric laminates are compared with results for laminates made from AS4/PEEK unidirectional tape. The results indicate that the tension and compression moduli for quasi-isotropic and orthotropic laminates made from fabric materials are at least 98 pct. of the modulus of equivalent laminates made from tape materials. The strength of fabric material laminates is at least 80 pct. of laminates made from tape material. The evaluation of the fabric material for shear stiffness indicates that a tape material laminate could be replaced by a fabric material laminate and still maintain 89 pct. of the shear stiffness of the tape material laminate. Author

N91-24344 Florida Univ., Gainesville.

DYNAMIC DELAMINATION PROPAGATION IN COMPOSITE BEAMS UNDER IMPACT Ph.D. Thesis

Shoufeng Hu 1990 149 p

Avail: Univ. Microfilms Order No. DA9106424

Interlaminar crack growth of composite beams with embedded delaminations under impact loading was analyzed. A superposition technique is proposed for obtaining an analytical solution for the shear stress field in short composite beam under transverse loading, for which the shear stress plays a large role in the interlaminar failure. High shear stress concentration is shown in the results. A node shifting technique is used to solve 2-D fracture problems using a 1-D beam element. The technique was successful in calculating the energy release rate of a beam with an embedded delamination. An elastic foundation spring model is used to compute the dynamics energy release rate. In the model, a delaminated beam is replaced by two separate beams joined together with a distributed spring at the uncracked part of the original beam. The energy release rate of the crack is equivalent to the potential energy per unit area of the spring at the crack tip. Pendulum impact tests were done to study the validity of the theoretical model and the numerical analysis, as well as to compare pendulum impact with projectile impact. Agreement between experimental and theoretical results was obtained. Dissert. Abstr.

N91-24345*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLICATION OF ARTIFICIAL NEURAL NETWORKS TO COMPOSITE PLY MICROMECHANICS
D. A. Brown (Wooster Coll., OH.), P. L. N. Murthy, and L. Berke 1991 24 p Presented at the Engineering Mechanics Conference, Columbus, OH, 19-22 May 1991; sponsored by the American Society of Civil Engineers
(NASA-TM-104365; E-6162; NAS 1.15:104365) Avail: NTIS HC/MF A03 CSCL 11D

Artificial neural networks can provide improved computational efficiency relative to existing methods when an algorithmic description of functional relationships is either totally unavailable or is complex in nature. For complex calculations, significant reductions in elapsed computation time are possible. The primary goal is to demonstrate the applicability of artificial neural networks to composite material characterization. As a test case, a neural network was trained to accurately predict composite hygral, thermal, and mechanical properties when provided with basic information concerning the environment, constituent materials, and component ratios used in the creation of the composite. A brief introduction on neural networks is provided along with a description of the project itself. Author

N91-24346*# Clemson Univ., SC. Dept. of Mechanical Engineering.
MICRO-MECHANICAL ANALYSIS OF DAMAGE GROWTH AND FRACTURE IN DISCONTINUOUS FIBER REINFORCED METAL MATRIX COMPOSITES Final Report, 1 Jan. 1989 - 31 Jan. 1991
James G. Goree and David E. Richardson 10 Jun. 1991 27 p (Grant NAG1-971)
(NASA-CR-188206; NAS 1.26:188206) Avail: NTIS HC/MF A03 CSCL 11D

An experimental verification is presented for a new two parameter fracture model based on the equivalent remote biaxial stresses (ERBS). A detailed comparison is made between the new theory and the constant K(sub IC) approach of linear elastic fracture mechanics (LEFM). Fracture is predicted through a failure curve representing the change in a variable fracture toughness K(sub IC) with the ERBS ratio B(sub E). The nonsingular term (T) in the series expansion of the near crack-tip transverse stress is included in the model. Experimental results for polymethyl methacrylate (PPMA) show that the theory can account for the effects of geometry on fracture toughness as well as indicate the initiation of crack branching. It is shown that the new criterion predicts failure for PMMA with a 95 percent confidence zone which is nearly three times smaller than that of the LEFM K(sub IC) approach. Author

N91-24347# Aerospatiale Aquitaine, Saint-Medard en Jalles (France).
NONDESTRUCTIVE TESTING OF COMPOSITE STRUCTURES BY X RAY TOMOGRAPHY [LE CONTROLE NON DESTRUCTIF DES STRUCTURES COMPOSITES PAR TOMOGRAPHIE A RAYONS X]
Pierre Barbier and Philippe Morisseau (Intercontrole, Rungis, France) 1991 7 p In FRENCH; ENGLISH summary
(Rept-911-430-110; ETN-91-99282) Avail: NTIS HC/MF A02

X ray computed tomography is used for the purpose of verifying large size motor cases. The objects to be inspected and the types of defect to be found are described. Numerous tests carried out on samples confirm the advantages of tomography over the other non destructive testing techniques. The acquisition system and the imaging reconstruction system of the currently used tomograph are described. Tomography detected six additional defects which were not detected by radiography. Unexpected defects such as metallic inclusion are clearly shown using this method. ESA

N91-24348# Aerospatiale Aquitaine, Saint-Medard en Jalles (France).
EXAMINATION OF THE REMOVAL OF A HIGH MODULE WIRE PLACED ON A DEFORMABLE MANDREL [ETUDE DE LA DEPOSE D'UN FIL DE MODULE ELEVE SUR UN MANDRIN DEFORMABLE]
Georges Cahuzac, Yvon Degre, and Marc LeMonnier (Ecole Nationale des Arts et Industries Textiles, Roubaix, France) 1991 13 p In FRENCH
(Rept-911-430-116; ETN-91-99288) Avail: NTIS HC/MF A03

When components of various shapes are realized in composite materials, flexible mandrels are used for winding, which can make circumferential winding operation difficult. When the composite wire is wound on a circular section, a tension (T) is applied to the wire, which exerts a pressure (P) which is proportional to T on its bracket. The total pressure exerted on the mandrel in addition to the partial pressures resulting from each existing layer, rapidly grows high and the mandrel subsides on itself. The various layers relax to various degrees up to a null tension. Some of them submitted to compression forces, are warped. Such an undulation phenomenon, induces catastrophic consequences on the mechanical properties of the composite materials, as obtained at the end of the densification cycle. A theoretical mechanical investigation aimed at preventing such a phenomenon is presented. ESA

N91-24349# Naval Ship Research and Development Center, Annapolis, MD. Ship Materials Engineering Dept.
A FRAMEWORK FOR 3-D NONLINEAR MODELING OF THICK-SECTION COMPOSITES
David A. Pecknold Oct. 1990 60 p
(AD-A232973; DTRC/SME-90/92) Avail: NTIS HC/MF A04 CSCL 11/4

An architecture is proposed for 3-D nonlinear material modeling of thick section composite laminates, which may have thicknesses ranging from 1/4 in. up to several inches. In this thickness range, there is very little applications-related experience or experimental information available; the potential effects of out-of-plane stresses and strains on material properties and behavior are therefore of great concern. The material is intended to be used as a component of a standard finite element structural analysis package; this places severe practical limits on material model complexity. The model consists of two main components: a laminamicro-model containing fiber and matrix elements and a simplified unit-cell analysis; and a sublaminate model based on a 3-D lamination theory which enforces equilibrium of out-of-plane stresses. GRA

N91-24350# Washington Univ., Saint Louis, MO. Center for Computational Mechanics.
HIERARCHIC MODELS FOR LAMINATED COMPOSITES
Ivo Babuska, Barna A. Szabo, and Ricardo L. Actis Dec. 1990 49 p
(AD-A233258; WU/CCM-90/4) Avail: NTIS HC/MF A03 CSCL 11/4

The principles governing the formulation of hierarchic models for laminated composites are discussed. The essential features of the hierarchic models describes herein are: (1) the exact solutions corresponding to the hierarchic sequence of models converge to the exact solution of the corresponding problem of elasticity for a fixed laminate thickness; and (2) the exact solution of each model converges to the same limit as the exact solution of the corresponding problem of elasticity with respect to the laminate thickness approaching zero. Hierarchic models make the computation of any engineering data possible to an arbitrary level of precision within the framework of the theory of elasticity. GRA

N91-24351# Boeing Advanced Systems Co., Seattle, WA.
COMPENDIUM OF FRACTOGRAPHIC DATA FOR COMPOSITE MATERIALS Interim Report, 22 Sep. 1986 - 31 Oct. 1988
Cam Hua and Mike Yamashita Dec. 1989 360 p
(Contract F33615-86-C-5071)

(AD-A233400; WRDC-TR-89-4055) Avail: NTIS HC/MF A16 CSCL 11/4

The objective of this program is to enhance the capability of the Air Force in conducting failure analysis investigations on composite structures. The details of the first six tasks are presented and include: (1) identification of techniques for field failure analysis; (2) fractographic techniques other than microscopic examination of the fracture surfaces; (3) a fractographic data base of specimens failed under controlled test conditions; (4) a chemical and mechanical property data base of constituent and composite materials; (5) data collection format sheets; and (6) several failure analysis investigations for illustrative purposes. The largest portion of the program was devoted to the fractographic data base which includes carbon, fiberglass, kevlar, and boron epoxy composites as well as carbon fiber, non-brittle epoxy composites such as carbon/PEEK, carbon/PMR-15, and carbon/ multiphase resins (X8551). GRA

N91-24352# Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.

DARPA-MATERIALS RESEARCH COUNCIL SUMMER CONFERENCE Summary Report

M. J. Sinnott Jul. 1990 219 p Conference held in La Jolla, CA, 9 Jul. - 3 Aug. 1990

(Contract N00014-87-J-1217)

(AD-A233401) Avail: NTIS HC/MF A10 CSCL 11/4

The principal task of this ONR-DARPA grant is to bring together a group of the country's leading scientists and engineers for an extended period, to permit them to apply their combined talents to the planning and scoping of future materials research areas for DOD. Workshop topics summarized include: structural acoustics with application to submersible vehicles; electrochemical power sources; mechanical fatigue performance and reliability in advanced composites; bundled fibers as a toughness enhancer in fiber composites; high temperature intermetallic matrix composites to engines; and a report on the rump session on intelligent processing of materials/hot isostatic pressing. The following topics are also covered: nanostructural materials; nonstationary signal processing-wavelets, Wigner-Ville, etc.; intelligent control for manufacturing; real-time, noncontact measurement of optical constants emissivities and true temperature by laser ellipsometry; high temperature superconductivity; and diamond films as substrates. Other areas addressed include: halogen-assisted chemical vapor deposition of diamond; image processing and sensor fusion; nonvolatile memories workshop; micro-mechanics/ micro-motors DARPA/MRC workshop; a workshop of optical computing; high-energy substances; and smart materials and structures. GRA

N91-24353# Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.

FLEXURAL FATIGUE BEHAVIOR OF ARALL (TRADEMARK) LAMINATES Final Report, 1 Jun. 1989 - 1 Aug. 1990

Jeffrey Cook and Mary E. Donnellan 1 Aug. 1990 35 p

(AD-A233451; NADC-90073-60) Avail: NTIS HC/MF A03 CSCL 11/4

Axial fatigue testing has shown that ARALL laminates possess outstanding fatigue resistance compared to monolithic aluminum alloys in tension dominated cyclic loads. The fatigue behavior of 3/2 and 5/4 ply ARRALL-4 in pure flexure (R=-1) is examined. The effect of salt-fog exposure on fatigue response was also investigated. Results indicate that, in general, failure occurs in three stages: cracking of the outer aluminum surfaces; delamination at the interfaces between fiber-rich and resin-rich regions; and fiber failure. The flexural fatigue resistance of ARALL-4 was found to be excellent; compressive stresses did not contribute significantly to failure of the laminates. GRA

N91-24354# Engineering Societies Library, New York.

INTERNATIONAL CONFERENCE ON MECHANICAL FATIGUE OF ADVANCED MATERIALS Final Report, 30 Sep. 1990 - 30 Jun. 1991

R. O. Ritchie, R. H. Dauskardt, and B. N. Cox 15 Feb. 1991 24 p

(Contract DAAL03-91-G-0037; AF-AFOSR-0350-90; AF Proj. 2306)

(AD-A233545; ARO-28019.1-MS-CF; AFOSR-91-0210TR) Avail: NTIS HC/MF A03 CSCL 11/4

This document provides a description and technical summary of the International Engineering Foundation Conference on Mechanical Fatigue of Advanced Materials, 13-18 January 1991. It provides a current assessment of the pertinent issues with respect to general microstructural and compositional design strategies, evaluation of mechanical properties, characterization of damage, failure and crack-tip shielding modes, and (potential) life-prediction procedures for metal matrix composites, intermetallics and intermetallic matrix composites, and ceramics and ceramic matrix composites. In addition, there is some discussion of future trends in advanced materials, covering both the optimization of both microstructure and composite architecture. GRA

N91-24355# Martin Marietta Corp., Orlando, FL.

XD(TM) REINFORCED BERYLLIUM-BASED COMPOSITES Final Report, Mar. 1989 - Aug. 1990

Wendell Meyerer, Al Bopp, and Fritz Grensing Dec. 1990 84 p

(Contract F33615-89-C-5614)

(AD-A233587; OR-20-099; WRDC-TR-90-4103) Avail: NTIS HC/MF A05 CSCL 11/4

Eleven beryllium castings were made by Brush Wellman using dispersoid materials provided by Martin Marietta Laboratories. Eight castings had a beryllium matrix, while three had a NiBe matrix. Each casting was analyzed metallographically. It was found that all the selected dispersoid materials reacted with the beryllium matrix. Little grain refinement was observed in the castings. Slabs cut from the cast billets were rolled to produce sheet. It was found that the grain size of the rolled material was slightly finer than a pure Be control sample. GRA

N91-24356# Department of the Navy, Washington, DC.

METHOD FOR PROVIDING EMI/EMP HARDENING AND BREAKDOWN PROTECTION IN COMPOSITE MATERIALS Patent Application

David Dixon, inventor (to Navy) and James Masi, inventor (to Navy) 20 Jun. 1990 21 p

(AD-D014846; US-Patent-Appl-SN-544298) Avail: NTIS HC/MF A03 CSCL 09/7

This patent application discloses an electrical equivalent circuit and an electromagnetic prediction model for composite materials composed of conducting and semiconducting particles, fibers, or flakes in a matrix of polymeric material for use in connectors, junction boxes, enclosures or similar electromagnetic shielding applications. The development of this model and predictive capability will enable one to develop a range of composite materials with the desired Conductivity, Corrosion Resistance, EM Shielding and Pulse Breakdown capabilities. Only the use of a composite material with electromagnetic (EM) shielding properties built into the material itself, combined with the use of conductive and semiconductive fillers that will minimize the corrosive effect of electrochemical potential differences, will provide a total long-term solution to ensure that EM shielding and corrosion resistance is maintained in these materials when they are used in ocean environments and aircraft environments. The equivalent circuit and model also considers the effect that oxides as semiconductor materials and electromagnetically/galvanically compatible conductive fillers also provide a basis for a new class of EMI and EMP composite materials that exhibit stable current and voltage controlled negative resistance. GRA

N91-24357# Department of the Navy, Washington, DC.

COMPOSITE MATERIAL FOR EMI/EMP HARDENING PROTECTION IN MARINE ENVIRONMENTS Patent Application

David Dixon, inventor (to Navy) and James Masi, inventor (to Navy) 20 Jun. 1990 16 p

(AD-D014847; US-Patent-Appl-SN-544297) Avail: NTIS HC/MF A03 CSCL 13/10

This patent application is co-pending with related patent

application entitled Method for Providing EMI/EMP Hardening and Breakdown Protection in Composite Materials by the same inventors filed on the same date as this application. The present invention relates to conductive composite materials and more particularly to composite materials for shielding against the effects of EMI/EMP in corrosive marine environments. It is well known that existing methods of improving the electromagnetic interference (EMI) and electromagnetic pulse (emp) performance of lightweight non-corrosive, nonmetallic materials, so often used in today's commercial and military enclosures, have typically utilized coatings, platings and/or separate metallic layers. Coatings and platings on present nonmetallic materials have not provided acceptable solutions in the areas of material adhesion, adequate shielding effectiveness and material electrochemical compatibility when interfaced with other materials. GRA

N91-24358*# Boeing Commercial Airplane Co., Seattle, WA.
ENVIRONMENTAL EXPOSURE EFFECTS ON COMPOSITE MATERIALS FOR COMMERCIAL AIRCRAFT Final Report, 22 Nov. 1977 - 31 Dec. 1990
Daniel J. Hoffman and William J. Bielawski Jan. 1991 129 p
(Contract NAS1-15148)
(NASA-CR-187478; NAS 1.26:187478) Avail: NTIS HC/MF A07 CSCL 11D

A study was conducted to determine the effects of long term flight and ground exposure on three commercially available graphite-epoxy material systems: T300/5208, T300/5209, and T300/934. Sets of specimens were exposed on commercial aircraft and ground racks for 1, 2, 3, 5, and 10 years. Inflight specimen sites included both the interior and exterior of aircraft based in Hawaii, Texas, and New Zealand. Ground racks were located at NASA-Dryden and the above mentioned states. Similar specimens were exposed to controlled lab conditions for up to 2 years. After each exposure, specimens were tested for residual strength and a dryout procedure was used to measure moisture content. Both room and high temperature residual strengths were measured and expressed as a pct. of the unexposed strength. Lab exposures included the effects of time alone, moisture, time on moist specimens, weatherometer, and simulated ground-air-ground cycling. Residual strengths of the long term specimens were compared with residual strengths of the lab specimens. Strength retention depended on the exposure condition and the material system. Results showed that composite materials can be successfully used on commercial aircraft if environmental effects are considered. Author

N91-24359*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INCREASED HEAT TRANSFER TO A CYLINDRICAL LEADING EDGE DUE TO SPANWISE VARIATIONS IN THE FREESTREAM VELOCITY
D. L. Rigby (Sverdrup Technology, Inc., Brook Park, OH.) and G. J. VanFossen 1991 13 p Presented at the 22nd Fluid Dynamics, Plasma Dynamics and Lasers Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(Contract NAS3-25266)
(NASA-TM-104464; E-6306; NAS 1.15:104464; AIAA-91-1739)
Avail: NTIS HC/MF A03 CSCL 11D

The present study numerically demonstrates how small spanwise variations in velocity upstream of a body can cause relatively large increases in the spanwise-averaged heat transfer to the leading edge. Vorticity introduced by spanwise variations, first decays as it drifts downstream, then amplifies in the stagnation region as a result of vortex stretching. This amplification can cause a periodic array of 3 D structures, similar to horseshoe vortices, to form. The numerical results indicate that, for the given wavelength, there is an amplitude threshold below which a structure does not form. A one-dimensional analysis, to predict the decay of vorticity in the absence of the body, in conjunction with the full numerical results indicated that the threshold is more accurately stated as minimum level of vorticity required in the leading edge region for a structure to form. It is possible, using the one-dimensional analysis, to compute an optimum wavelength in terms of the maximum vorticity reaching the leading edge region for given amplitude. A discussion is presented which relates experimentally observed trends to the trends of the present phenomena. Author

N91-24360*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HIGH TEMPERATURE TENSION-COMPRESSION FATIGUE BEHAVIOR OF A TUNGSTEN COPPER COMPOSITE
Michael J. Verrilli and Timothy P. Gabb 1990 11 p Presented at the Fourth Symposium on Composite Materials, Indianapolis, IN, 6-7 May 1991; sponsored by the American Society for Testing and Materials
(NASA-TM-104370; E-6174; NAS 1.15:104370) Avail: NTIS HC/MF A03 CSCL 11D

The high temperature fatigue of a (O)12 tungsten fiber reinforced copper matrix composite was investigated. Specimens having fiber volume percentages of 10 and 36 were fatigued under fully-reversed, strain-controlled conditions at both 260 and 560 C. The fatigue life was found to be independent of fiber volume fraction because fatigue damage preferentially occurred in the matrix. Also, the composite fatigue lives were shorter at 560 C as compared to 260 C due to changes in mode of matrix failure. On a total strain basis, the fatigue life of the composite at 560 C was the same as the life of unreinforced copper, indicating that the presence of the fibers did not degrade the fatigue resistance of the copper matrix in this composite system. Comparison of strain-controlled fatigue data to previously-generated load-controlled data revealed that the strain-controlled fatigue lives were longer because of mean strain and mean stress effects. Author

N91-24361*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A COMPARISON OF FIBER EFFECTS ON POLYMER MATRIX COMPOSITE OXIDATION
Kenneth J. Bowles 1991 18 p Presented at the Second Japan International Symposium and Exhibition, Chiba, Japan, 11-14 Dec. 1991; sponsored by the Society for the Advancement of Materials and Process Engineering
(NASA-TM-104416; E-6248; NAS 1.15:104416) Avail: NTIS HC/MF A03 CSCL 11D

A number of thermo-oxidative stability studies addressing the effects of fiber reinforcement on composite thermal stability and influence of geometry on the results of aging studies were performed at NASA-Lewis. The information presented herein, a compilation of some results from these studies, shows the influence of the reinforcement fibers on the oxidative degradation of various PMR-15 composites. Reinforcement of graphite and ceramics were studied and three composite oxidation mechanisms were observed. One was a dominant attack of the reinforcement fiber, the second was the aggressive oxidation of the matrix material, and the third was interfacial degradation. Author

N91-24311*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TENSILE AND FATIGUE BEHAVIOR OF TUNGSTEN/COPPER COMPOSITES
Michael J. Verrilli, Timothy P. Gabb, and Y. S. Kim *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 25-31 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11D

N91-25049*# Aerospace Corp., El Segundo, CA.
EXPERIMENT M0003-10: ADVANCED COMPOSITES Abstract Only
Gary L. Steckel and Tuyen D. Le *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 82 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

N91-25050*# Boeing Aerospace and Electronics Co., Seattle, WA.
RESULTS FROM ANALYSIS OF BOEING COMPOSITE SPECIMENS FLOWN ON LDEF EXPERIMENT M0003 Abstract Only
Sylvester G. Hill, Pete George, E. Russ Crutcher, Harry Dursch, and H. Gary Pippin *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 83 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

N91-25051*# Lockheed Missiles and Space Co., Sunnyvale, CA.
LDEF-SPACE ENVIRONMENTAL EFFECTS ON MATERIALS: COMPOSITES AND SILICONE COATINGS Abstract Only
Brian C. Petrie *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 84 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

N91-25052*# Michigan Univ., Ann Arbor.
HIGH-TOUGHNESS GRAPHITE/EPOXY COMPOSITE MATERIAL EXPERIMENT Abstract Only
David K. Felbeck *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 85 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

N91-25053*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF LDEF FLIGHT EXPOSURE ON SELECTED POLYMER MATRIX RESIN COMPOSITE MATERIALS Abstract Only
Wayne S. Slemp, Philip R. Young, William G. Witte, Jr., and James Y. Shen (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 86 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

N91-25054*# Aerospatiale, Les Mureaux (France).
EFFECT OF SPACE ENVIRONMENT ON COMPOSITE MATERIALS AND THERMAL COATINGS (AO 138-9) Abstract Only
Michel Parcelier *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 87 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

N91-25055*# MATRA Espace, Toulouse (France).
EFFECT OF SPACE EXPOSURE OF SOME EPOXY MATRIX COMPOSITES ON THEIR THERMAL EXPANSION AND MECHANICAL PROPERTIES (AO 138-8) Abstract Only
Heinrich Jabs *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 88 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

N91-25056*# Rockwell International Corp., Tulsa, OK.
EVALUATION OF LONG-DURATION EXPOSURE TO THE NATURAL SPACE ENVIRONMENT ON GRAPHITE-POLYIMIDE AND GRAPHITE-EPOXY MECHANICAL PROPERTIES Abstract Only
Richard F. Vyhnal, Douglas W. Welch, and Howard J. Powell *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 89 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

N91-24362*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PURIFICATION SYSTEM Patent Application
David T. Flanagan, inventor (to NASA) and Randall E. Gibbons, inventor (to NASA) (Krug International, Houston, TX.) 8 Jan. 1991 13 p
(NASA-Case-MSC-21584-1; NAS 1.71:MSC-21584-1; US-Patent-Appl-SN-638600) Avail: NTIS HC/MF A03 CSCL 07D

A system for prolonging the life of a granulated activated charcoal (GAC) water treatment device is disclosed in which an ultraviolet light transparent material is used to constrain water to flow over carbon surfaces. It is configured to receive maximum flux from a UV radiation source, for the purpose of preventing microbial proliferation on the carbon surfaces, oxidizing organic contaminants adsorbed from the water onto the carbon surfaces and from biodegradation of adsorbed microbial forms, disinfecting water, and oxidizing organic contaminants in the water. NASA

N91-24363 Georgia Inst. of Tech., Atlanta.
DRIVING OF AXIAL ACOUSTIC FIELDS BY SIDEWALL-STABILIZED DIFFUSION FLAMES Ph.D. Thesis
Tzengyuan Chen 1990 166 p
Avail: Univ. Microfilms Order No. DA9105425

The objectives were the following: (1) to investigate the mechanisms responsible for the driving of axial instabilities by solid propellant flames; (2) to determine whether state of the art theoretical models can predict the characteristics of the flame driving mechanisms; and (3) to investigate the effect of flow turning upon axial instabilities in solid propellant rocket motors. To attain these objectives, the response of diffusion flames, stabilized on the side wall of a duct, to imposed axial acoustic waves were investigated by using high speed shadow-graph movies, a light intensified imaging system, flame radiation measurements, laser Doppler velocimeter (LDV), and acoustic pressure measurements. The validity of a developed flame response model was investigated by comparing measured and predicted oscillatory velocity components in the flame region. To utilize the development model, data describing the steady state temperature distribution in the flame region, the flame shape, and the acoustic admittance of the burner surface were needed as inputs. Using the measured input data, the developed model was used to predict oscillatory vertical velocity distributions in the flame region. These were then compared with the velocity distributions measured with the LDV system. Dissert. Abstr.

N91-24364 Michigan Univ., Ann Arbor.
STRUCTURE AND RADIATION PROPERTIES OF TURBULENT DIFFUSION FLAMES Ph.D. Thesis
Michael Emmanuel Kounalakis 1990 271 p
Avail: Univ. Microfilms Order No. DA9034457

A theoretical and experimental study of the flame structure and gas band radiation of carbon monoxide/hydrogen/air diffusion flames is described. The results have applications to analysis of the rate of spread of natural fires, design and development of furnaces, determination of radiant heat loads to engine components, development of rocket plume visibility, safe operations of industrial flares, development of material test codes for fire properties and development of fire detectors. The structure of the turbulent flames was studied using the Mie scattering technique to measure single and two-point mixture fraction statistics, and laser Doppler anemometery to measure single-point velocity statistics along the centerline. A stochastic methodology for treating the nonlinear flame radiation fluctuations caused by turbulence/radiation interactions was developed. The methodology

was evaluated by comparison with high resolution emission spectroscopy measurements of gas-band radiation.
Dissert. Abstr.

N91-24365*# Arizona Univ., Tucson. NASA Space Engineering Research Center.
NASA SPACE ENGINEERING RESEARCH CENTER FOR UTILIZATION OF LOCAL PLANETARY RESOURCES Annual Progress Report, 1990-1991
Kumar Ramohalli and John S. Lewis Apr. 1991 262 p Original contains color illustrations
(NASA-CR-188222; NAS 1.26:188222) Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

In the processing of propellants, volatiles, and metals subject area, the following topics are discussed: reduction of lunar regolith; reduction of carbon dioxide; and reduction of carbonaceous materials. Other areas addressed include: (1) production of structural and refractory materials; (2) resource discovery and characterization; (3) system automation and optimization; and (4) database development. The majority of these topics are discussed with respect to the development of lunar and mars bases. Some main topics of interest include: asteroid resources, lunar resources, mars resources, materials processing, construction materials, propellant production, oxygen production, and space-based oxygen production plants. For individual titles, see N91-24366 through N91-24391.

N91-24366*# Arizona Univ., Tucson. Lunar and Planetary Lab.
COPRODUCTION OF VOLATILES AND METALS FROM EXTRATERRESTRIAL MATERIALS **c26**
John S. Lewis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 3 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 11F

Two main efforts in support of the general goals of SERC/culpr are presented. Investigations of processes for the coproduction of metals from extra-terrestrial materials in conjunction with plausible schemes for oxygen extraction continue. The principal emphasis was on the extraction and purification of iron from the ilmenite reduction process for oxygen, from the cathode metal deposits made in the magma electrolysis process for oxygen, and from native ferrous metal alloys on the moon and asteroids. All work on the separation and purification of ferrous metals was focussed upon the gaseous carbonyl process, a scheme that involves only temperatures attainable by passive thermal control. The exploration of a variety of schemes was initiated, involving the use of several different propulsion options and both propulsive and aerobraking capture at earth, for return of extraterrestrial resources to earth orbits. In addition, the search for new opportunities in space resource utilization continues. Examples include the continuation of work underway on: (1) the feasibility of locating solar power satellites in highly eccentric earth orbit; (2) the energetics of extracting the potential clean fusion fuel He-3 from the atmosphere for return to earth; and (3) the utility of a nuclear steam rocket (using non-terrestrial water as the working fluid) for transportation in the inner solar system. Author

N91-24367*# Arizona Univ., Tucson. Dept. of Chemical Engineering.
PRODUCTION OF OXYGEN FROM LUNAR ILMENITE
F. Shadman and Y. Zhao *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 29 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

The kinetics and the mechanism of reduction of synthetic ilmenite by hydrogen in the temperature range of 807 to 1014 C were investigated. At temperatures below 876 C, the temporal profiles of conversion have a sigmoidal shape and indicate the presence of three different stages (induction, acceleration, and deceleration) during the reduction reaction. The apparent activation energy for the reaction is 22.3 kcal/mole, whereas the intrinsic activation energy is 16.9 kcal/mole. Scanning electron microscopy and energy dispersive x-ray analyses show that the diffusion of Fe product away from the reaction front and through the TiO2 phase, followed by the nucleation and growth of a separate Fe phase is an important step affecting the process kinetics. X-ray diffraction and wavelength dispersive x-ray results indicate that the TiO2 can be reduced to lower oxides of titanium at temperatures higher than 876 C. Author

N91-24368*# Arizona Univ., Tucson. Dept. of Geoscience.
BENEFICIATION OF LUNAR ILMENITE
Joaquin Ruiz *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 3 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

One of the most important commodities lacking in the moon is free oxygen which is required for life and used extensively for propellent. Free oxygen, however, can be obtained by liberating it from the oxides and silicates that form the lunar rocks and regolith. Ilmenite (FeTiO3) is considered one of the leading candidates for production of oxygen because it can be reduced with a reasonable amount of energy and it is an abundant mineral in the lunar regolith and many mare basalts. In order to obtain oxygen from ilmenite, a method must be developed to beneficiate ilmenite from lunar material. Two possible techniques are electrostatic or magnetic methods. Both methods have complications because lunar ilmenite completely lacks Fe(3+). Magnetic methods were tested on eucrite meteorites, which are a good chemical simulant for low Ti mare basalts. The ilmenite yields in the experiments were always very low and the eucrite had to be crushed to xxxx. These data suggest that magnetic separation of ilmenite from fine grain lunar basalts would not be cost effective. Presently, experiments are being performed with electrostatic separators, and lunar regolith is being waited for so that simulants do not have to be employed.
Author

N91-24369*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
COLD PLASMA PROCESSING OF LOCAL PLANETARY ORES FOR OXYGEN AND METALLURGICALLY IMPORTANT METALS
D. C. Lynch, D. Bullard, and R. Ortega *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 16 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

The utilization of a cold or nonequilibrium plasma in chlorination processing is discussed. Titanium dioxide (TiO2) was successfully chlorinated at temperatures between 700 and 900 C without the aid of carbon. In addition to these initial experiments, a technique was developed for determining the temperature of a specimen in a plasma. Development of that technique has required evaluating the emissivity of TiO2, ZrO2, and FeOTiO2 and analyzing the specimen temperature in a plasma as a function of both power absorbed by the plasma and the pressure of the plasma. The mass spectrometer was also calibrated with TiCl4 and CCl4 vapor. Author

N91-24370*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
INNOVATIVE TECHNIQUES FOR THE PRODUCTION OF ENERGETIC RADICALS FOR LUNAR MATERIALS PROCESSING INCLUDING PHOTOGENERATION VIA CONCENTRATED SOLAR ENERGY
D. E. Osborn, D. C. Lynch, and R. Fozzolari *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 5 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

A technique for photo generation of radicals is discussed that can be used in the recovery of oxygen and metals from extraterrestrial resources. The concept behind this work was to examine methods whereby radicals can be generated and used in the processing of refractory materials. In that regard, the focus is on the use of sunlight. Sunlight provides useful energy for

processing in the forms of both thermal and quantum energy. A number of experiments were conducted in the chlorination of metals with and without the aid of UV and near UV light. The results of some of those experiments are discussed. Author

N91-24371*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Science.

OXYGEN AND IRON PRODUCTION BY ELECTROLYTIC SMELTING OF LUNAR SOIL

R. O. Colson and L. A. Haskin *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 11 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

Oxygen, present in abundance in nearly all lunar materials, can theoretically be extracted by molten silicate electrolysis from any known lunar rock. Derivation of oxygen by this method has been amply demonstrated experimentally in silicate melts of a variety of compositions. This work can be divided into three categories: (1) measurement of solubilities of metals (atomic) in silicate melts; (2) electrolysis experiments under various conditions of temperature, container material, electrode configuration, current density, melt composition, and sample mass (100 to 2000 mg) measuring energy required and character of resulting products; and (3) theoretical assessment of compositional requirements for steady state operations of an electrolysis cell. Author

N91-24372*# EMEC Consultants, Export, PA.

EXPERIMENTAL STUDY OF THE ELECTROLYSIS OF SILICATE MELTS

R. Keller and K. T. Larimer *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

To produce oxygen from lunar resources, it may be feasible to melt and electrolyze local silicate ores. This possibility was explored experimentally with synthesized melts of appropriate compositions. Platinum electrodes were employed at a melt temperature of 1425 C. When silicon components of the melt were reduced, the platinum cathode degraded rapidly, which prompted the substitution of a graphite cathode substrate. Discrete particles containing iron or titanium were found in the solidified electrolyte after three hours of electrolysis. Electrolyte conductivities did not decrease substantially, but the escape of gas bubbles, in some cases, appeared to be hindered by high viscosity of the melt. Author

N91-24373*# Tennessee Univ., Knoxville. Dept. of Materials Science and Engineering.

AN INVESTIGATION OF THE THERMAL SHOCK RESISTANCE OF LUNAR REGOLITH AND THE RECOVERY OF HYDROGEN FROM LUNAR SOIL HEATED USING MICROWAVE RADIATION

T. T. Meek *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 10 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

The objective is to develop a better understanding of the thermal shock properties of lunar regolith sintered using 2.45 GHz electromagnetic radiation and to do a preliminary study into the recovery of bound hydrogen in lunar soil heated using 2.45 GHz radiation. During the first phase of this work, lunar simulant material was used to test whether or not microhardness data could be used to infer thermal shock resistance and later actual lunar regolith was used. Results are included on the lunar regolith since this is of primary concern and not the simulant results. They were similar, however. The second phase investigated the recovery of hydrogen from lunar regolith and results indicate that microwave heating of lunar regolith may be a good method for recovery of bound gases in the regolith. Author

N91-24374*# Arizona Univ., Tucson. UA NASA SERC and Aerospace and Mechanical Engineering.

OXYGEN PLANT BREADBOARD DESIGN, AND TECHNIQUES FOR IMPROVING MISSION FIGURE-OF-MERIT **c31**

Kumar Ramohalli *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p Original contains color illustrations (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

A breadboard oxygen plant to process anaerobic carbon dioxide is designed and constructed; the objective is not only to produce a key propellant component extraterrestrially, but also to develop the important technologies that are necessary for a successful operation of in-situ materials utilization hardware. The solid electrolytic cells are supplied to specifications by an established vendor. The cell thermal control, electrical control, and flow control are installed after detailed designs. Extensive data are obtained that characterize the operation of the plant as the input parameters are varied. The initial mass, energy, and volume-needs provide the input to a figure-of-merit software program to calculate the impact of various candidate technologies upon the overall mission. The desirability of studies on storage and high-density propellants is shown. This task dovetails into other tasks that are evaluating alternative cell materials, catalysis for compactness, and smart sensors for effective control. Author

N91-24375*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.

THERMAL ANALYSIS, OPTIMIZATION AND DESIGN OF A MARTIAN OXYGEN PRODUCTION PLANT **c31**

Venkatesh A. Iyer and K. R. Sridhar *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 12 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

The objective is to optimally design the thermal components of a system that uses carbon dioxide (CO2) from the Martian atmosphere to produce oxygen (O2) for spacecraft propulsion and/or life-support. Carbon dioxide is thermally decomposed into carbon monoxide (CO) and O2 followed by the electrochemical separation of O2. The design of the overall system and its various individual components depends on, among other things, the fraction of the stoichiometric yield of O2 that can be realized in the system and the temperature of operation of the electrochemical separation membrane. The analysis indicates that a substantial reduction could be obtained in the mass and power requirements of the system if the unreacted CO2 were to be recycled. The concepts of an optimum temperature of the zirconia cell and impracticality of plant operation at low cell efficiencies are also discussed. The design of the thermal equipment is such that the mass and power requirements of the individual components and of the overall system are optimized. Author

N91-24376*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.

ISSUES ON THE PRODUCTION AND ELECTROCHEMICAL SEPARATION OF OXYGEN FROM CARBON DIOXIDE

P. Kaloupis and K. R. Sridhar *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 15 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

There is considerable interest in in-situ propellant manufacturing on the moon and Mars. One of the concepts of oxygen production that is being actively pursued is the processing of atmospheric carbon dioxide on Mars to produce oxygen by means of thermal decomposition and electrochemical separation. The key component of such a production facility is the electrochemical separation cell that filters out the oxygen from the gas mixture of carbon dioxide, carbon monoxide, and oxygen. Efficient design of the separation cell and the selection of electrolyte and electrode materials of superior performance for the cell would translate to significant reduction in the power requirement and the mass of the production facility. The objective is to develop the technology required to

produce the cells in-house and test various electrolyte and electrode materials systematically until the optimal combination is found. An effective technique was developed for the fabrication of disk shaped cells. Zirconia and Ceria cells were made in-house. Complete modules of the electrochemical cell and housings were designed, fabricated, and tested. Author

N91-24377*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.

COMPRESSION OF MARTIAN ATMOSPHERE FOR PRODUCTION OF OXYGEN

D. C. Lynch, A. H. Cutler, and P. E. Nolan *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 5 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

The compression of CO2 from the Martian atmosphere for production of O2 via an electrochemical cell is addressed. Design specifications call for an oxygen production rate of 10 kg per day and for compression of 50 times that mass of CO2. Those specifications require a compression rate of over 770 cfm at standard Martian temperature and pressure (SMTP). Much of the CO2 being compressed represents waste, unless it can be recycled. Recycling can reduce the volume of gas that must be compressed to 40 cfm at SMTP. That volume reduction represents significant mass savings in the compressor, heating equipment, filters, and energy source. Successful recycle of the gas requires separation of CO (produced in the electrochemical cell) from CO2, N2, and Ar found in the Martian atmosphere. That aspect was the focus of this work. Author

N91-24378*# Arizona Univ., Tucson. Dept. of Geosciences.

DEHYDRATION KINETICS OF TALC AT 1 BAR

J. Ganguly and K. Bose *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 14 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 07D

Experimental results on the dehydration kinetics of talc, which is likely to be a major potential resource for water and hydrogen in carbonaceous chondrites, is presented. The rate of dehydration of an essentially pure Mg-end member natural talc, (Mg(.99)Fe(.01))3Si4O10(OH)2, was studied by measuring in situ weight change under isothermal condition at 1 bar as a function of time in the temperature range 775 to 985 C. The grain size of the starting material was 0.7 to 1 micron. It was found that the data up to 50 to 60 percent dehydration can be fitted by an equation of the form alpha = exp(-Kt(exp n)), where alpha is the weight fraction of talc remaining, K is a rate constant and n is a numerical constant for a given temperature. For any set of isothermal data, there is a major change in the value of n for larger dehydration. For up to approximately 50 percent dehydration, all rate constants can be described by an Arrheniun relation with an activation energy of 432 (+/- 30) kJ/mol; n has a nearly constant value of 0.54 between 775 and 875 C, but increases almost linearly according to n = -10.77 + 0.012T C at T greater than or equal to 875 C. Author

N91-24379*# Arizona Univ., Tucson. Dept. of Chemistry.

RECOVERY OF PRECIOUS METALS FROM SPACE **c26**

Henry Freiser *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 14 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 11F

The overall objective is to develop efficient and economical separation and recovery methods for the platinum group and other precious metals. The separation of Pd(II) from Pt(II), Ir(III), and Rh(III) with trioctylphosphine oxide (TOPO) in heptane using centrifugal partition chromatography (CPC) was investigated. Activities to achieve this objective focussed on selection and evaluation of extraction systems for the PGM and modification of selected systems for multistage operation with a view to scaling up to desired macro levels. On the basis of preliminary evaluation of a series of simple metal complexing agents and chelating agents, the TOPO in heptane was selected as a likely system for isolating of Pd(II) and Pt(II) from the other PGM. A multistage apparatus capable of configuration as a simple rugged device, a centrifugal partition chromatograph (CPC), was shown to be effective. The extraction of Pd(II) was studied by CPC and batch solvent extraction. The distribution ratios for Pd(II) determined by both methods agree well. In low HCl concentrations (less than 0.1 M), the extracted species was PdCl2.(TOPO)2, irrespective of the chloride concentration, while at acid concentrations above 0.1 M, the Pd was extracted as the ion pair, 2(TOPO.H+).(PdCl4)2-. Base line separation of Pd(II) and Pt(II) in CPC was obtained under a variety of chloride and HCl concentration. It was demonstrated that the efficiency of CPC for metal separation was limited by chemical kinetic factors rather than instrumental factors, strongly suggesting that dramatic improvements can be achieved by studying reaction kinetics of formation and dissociation of the extractable metal complex. Author

N91-24380*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.

PROCESSING OF GLASS-CERAMICS FROM LUNAR RESOURCES **c27**

B. D. Fabes and W. H. Poisl *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 11C

The goal is to fabricate useful ceramic materials from the by-products of lunar oxygen production processes. Specifically, the crystal nucleation and growth kinetics of ilmenite-extracted lunar regolith were studied in order to produce glass-ceramics with optimal mechanical, thermal, and abrasion resistant properties. In the initial year of the program, construction and calibration of a high temperature viscometer, used for determining the viscosity of simulated lunar glasses was finished. A series of lunar simulants were also prepared, and the viscosity of each was determined over a range of temperatures. It was found that an increase in the concentration of Fe2O3 decreases the viscosity of the glass. While this may be helpful in processing the glass, Fe2O3 concentrations greater than approximately 10 wt percent resulted in uncontrolled crystallization during viscosity measurements. Impurities (such as Na2O, MnO, and K2O) in the regolith appeared to decrease the viscosity of the parent glass. These effects, as well as those of TiO2 and SiO2 on the processability of the glass, however, remain to be quantified. Author

N91-24381*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.

DEVELOPMENT AND MECHANICAL PROPERTIES OF STRUCTURAL MATERIALS FROM LUNAR SIMULANT **c31**

Chandra S. Desai *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

Development of versatile engineering materials from locally available materials in space is an important step toward establishment of outposts such as on the moon and Mars. Here development of the technologies for manufacture of structural and construction materials on the moon, utilizing local lunar soil (regolith), without the use of water, is an important element for habitats and explorations in space. It is also vital that the mechanical behavior such as strength and flexural properties, fracture toughness, ductility, and deformation characteristics are defined toward establishment of the ranges of engineering applications of the materials developed. The objectives include two areas: (1) thermal liquefaction of lunar simulant (at about 1100 C) with different additives (fibers, powders, etc.); and (2) development and use of a traxial test device in which lunar simulants are first compacted under cycles of loading, and then tested with different vacuums and initial confining or insitu stress. The second area was described in previous progress reports and publications; since the presently available device allows vacuum levels up to only 10(exp -4) torr, it is recommended that a vacuum pump that can allow higher levels of vacuum is acquired. Author

N91-24382*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
HIGH TEMPERATURE SEALS BETWEEN CERAMIC SEPARATION MEMBRANES AND SUPER-ALLOY HOUSING **c27**
G. Honea and K. R. Sridhar *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 5 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 11C

One of the concepts for oxygen production from Martian atmospheric carbon dioxide involves the use of tubular electrochemical membranes for oxygen separation. The tubular configuration offers the advantage of being able to separate the oxygen at pressures of up to 500 psi, thereby eliminating the need for a pre-liquefaction oxygen compressor. A key technology that has to be developed in order for the electrochemical separator to combine as a compressor is a high temperature static seal between the ceramic separation cell and the nickel-based super-alloy tube. Equipment was designed and fabricated to test the seals. Efforts are under way to develop a finite element model to study the thermal stresses at the joints and on the seal, and the optimal shape of the seal. The choice of seal materials and the technique to be used to fabricate the seals are also being investigated. Author

N91-24383*# Arizona Univ., Tucson. Dept. of Geosciences.
DETERMINATION OF LUNAR ILMENITE ABUNDANCES FROM REMOTELY SENSED DATA **c91**
Stephen M. Larson, Jeffrey R. Johnson, and Robert B. Singer *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 6 p Original contains color illustrations (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03B

The mineral ilmenite (FeTiO3) was found in abundance in lunar mare soils returned during the Apollo project. Lunar ilmenite often contains greater than 50 weight-percent titanium dioxide (TiO2), and is a primary potential resource for oxygen and other raw materials to supply future lunar bases. Chemical and spectroscopic analysis of the returned lunar soils produced an empirical function that relates the spectral reflectance ratio at 400 and 560 nm to the weight percent abundance of TiO2. This allowed mapping of the lunar TiO2 distribution using telescopic vidicon multispectral imaging from the ground; however, the time variant photometric response of the vidicon detectors produced abundance uncertainties of at least 2 to 5 percent. Since that time, solid-state charge-coupled device (CCD) detector technology capable of much improved photometric response has become available. An investigation of the lunar TiO2 distribution was carried out utilizing groundbased telescopic CCD multispectral imagery and spectroscopy. The work was approached in phases to develop optimum technique based upon initial results. The goal is to achieve the best possible TiO2 abundance maps from the ground as a precursor to lunar orbiter and robotic sample return missions, and to produce a better idea of the peak abundances of TiO2 for benefaction studies. These phases and the results are summarized. Author

N91-24384*# Arizona Univ., Tucson.
CONTINUOUS MONITORING OF THE LUNAR OR MARTIAN SUBSURFACE USING ON-BOARD PATTERN RECOGNITION AND NEURAL PROCESSING OF ROVER GEOPHYSICAL DATA **c91**
Charles E. Glass, Richard V. Boyd, and Ben K. Sternberg *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 21 p Original contains color illustrations (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03B

The overall aim is to provide base technology for an automated vision system for on-board interpretation of geophysical data. During the first year's work, it was demonstrated that geophysical data can be treated as patterns and interpreted using single neural networks. Current research is developing an integrated vision system comprising neural networks, algorithmic preprocessing, and expert knowledge. This system is to be tested incrementally using synthetic geophysical patterns, laboratory generated geophysical patterns, and field geophysical patterns. Author

N91-24385*# Arizona Univ., Tucson. Lunar and Planetary Lab.
SPACEWATCH SEARCH FOR NEAR-EARTH ASTEROIDS **c89**
Tom Gehreis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 3 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03A

The objective of the Spacewatch Program is to develop new techniques for the discovery of near-earth asteroids and to prove the efficiency of the techniques. Extensive experience was obtained with the 0.91-m Spacewatch Telescope on Kitt Peak that now has the largest CCD detector in the world: a Tektronix 2048 x 2048 with 27-micron pixel size. During the past year, software and hardware for optimizing the discovery of near-earth asteroids were installed. As a result, automatic detection of objects that move with rates between 0.1 and 4 degrees per day has become routine since September 1990. Apparently, one or two near-earth asteroids are discovered per month, on average. The follow up is with astrometry over as long an arc as the geometry and faintness of the object allow, typically three months following the discovery observations. During the second half of 1990, replacing the 0.91-m mirror with a larger one, to increase the discovery rate, was considered. Studies and planning for this switch are proposed for funding during the coming year. It was also proposed that the Spacewatch Telescope be turned on the sky, instead of having the drive turned off, in order to increase the rate of discoveries by perhaps a factor of two. Author

N91-24386*# Arizona Univ., Tucson. Lunar and Planetary Lab.
COMPOSITIONS OF NEAR-EARTH ASTEROIDS **c90**
L. A. Lebofsky and M. L. Nelson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03B

The goal is to determine whether any of the near-earth asteroids contain water-bearing phyllosilicate (clay) minerals. If these minerals are present, they would provide a readily available source of water for propellant generation and use in life support systems. Telescopic detection of water on the near-earth asteroids is complicated because thermal emission from the asteroid itself masks the diagnostic absorption features for objects this close to the sun. Sophisticated thermal models are necessary to determine whether the absorption features are present. This year, development of these models was continued and more telescopic data to test the models was obtained. Author

N91-24387*# Arizona Univ., Tucson. Aerospace and Mechanical Engineering.
DEVELOPMENT OF A FIGURE-OF-MERIT FOR SPACE MISSIONS **c12**
Bruce Preiss, Thomas Pan, and Kumar Ramohalli *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 6 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 22A

The concept of a quantitative figure-of-merit (FOM) to evaluate different and competing options for space missions is further developed. Over six hundred individual factors are considered. These range from mission orbital mechanics to in-situ resource utilization (ISRU/ISMU) plants. The program utilizes a commercial software package for synthesis and visual display; the details are completely developed in-house. Historical FOM's are derived for successful space missions such as the Surveyor, Voyager, Apollo, etc. A cost FOM is also mentioned. The bulk of this work is devoted to one specific example of Mars Sample Return (MSR). The program is flexible enough to accommodate a variety of evolving technologies. Initial results show that the FOM for sample return is a function of the mass returned to LEO, and that missions utilizing ISRU/ISMU are far more cost effective than those that rely on all earth-transported resources. Author

N91-24388*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.

QUANTITATIVE SIMULATION OF EXTRATERRESTRIAL ENGINEERING DEVICES **c31**

A. Arabyan, P. E. Nikravesh, and T. L. Vincent *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 6 p Original contains color illustrations (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

This is a multicomponent, multidisciplinary project whose overall objective is to build an integrated database, simulation, visualization, and optimization system for the proposed oxygen manufacturing plant on Mars. Specifically, the system allows users to enter physical description, engineering, and connectivity data through a uniform, user-friendly interface and stores the data in formats compatible with other software also developed as part of this project. These latter components include: (1) programs to simulate the behavior of various parts of the plant in Martian conditions; (2) an animation program which, in different modes, provides visual feedback to designers and researchers about the location of and temperature distribution among components as well as heat, mass, and data flow through the plant as it operates in different scenarios; (3) a control program to investigate the stability and response of the system under different disturbance conditions; and (4) an optimization program to maximize or minimize various criteria as the system evolves into its final design. All components of the system are interconnected so that changes entered through one component are reflected in the others. Author

N91-24389*# Arizona Univ., Tucson. Dept. of Electrical and Computer Engineering.

MODELING, SIMULATION, AND CONTROL OF AN EXTRATERRESTRIAL OXYGEN PRODUCTION PLANT **c31**

L. Schooley, F. Cellier, B. Zeigler, A. Doser, and G. Farrenkopf *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 6 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

The immediate objective is the development of a new methodology for simulation of process plants used to produce oxygen and/or other useful materials from local planetary resources. Computer communication, artificial intelligence, smart sensors, and distributed control algorithms are being developed and implemented so that the simulation or an actual plant can be controlled from a remote location. The ultimate result of this research will provide the capability for teleoperation of such process plants which may be located on Mars, Luna, an asteroid, or other objects in space. A very useful near-term result will be the creation of an interactive design tool, which can be used to create and optimize the process/plant design and the control strategy. This will also provide a vivid, graphic demonstration mechanism to convey the results of other researchers to the sponsor. Author

N91-24390*# Planetary Science Inst., Tucson, AZ.

NEAR-EARTH ASTEROIDS: OBSERVER ALERT NETWORK AND DATABASE ANALYSIS **c89**

Donald R. Davis and Clark R. Chapman *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 7 p (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03A

The Planetary Science Institute (PSI) was funded by SERCulpr to develop a communication network to alert observers of newly discovered near-earth asteroids (NEA's). This network is intended to encourage observers to obtain physical observations of NEA's, which are needed in order to characterize and assess the resource potential of these bodies. This network was declared operational in October 1990 via an announcement to the asteroid observing community. The PSI is also supported to develop the Near-Earth Asteroid Database (NEAD), a comprehensive database of physical and dynamical data on NEA's. In the past year, the database was updated on newly discovered NEA's during 1990, and new data on radar observations and dynamical classifications were added. Author

N91-24391*# Arizona Univ., Tucson. Steward Observatory.

THE STEWARD OBSERVATORY ASTEROID RELATIONAL DATABASE **c89**

Mark V. Sykes and Elizabeth M. AlvarezdelCastillo *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p Original contains color illustrations (For primary document see N91-24365 16-25)

Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03A

The Steward Observatory Asteroid Relational Database (SOARD) was created as a flexible tool for undertaking studies of asteroid populations and sub-populations, to probe the biases intrinsic to asteroid databases, to ascertain the completeness of data pertaining to specific problems, to aid in the development of observational programs, and to develop pedagogical materials. To date, SOARD has compiled an extensive list of data available on asteroids and made it accessible through a single menu-driven database program. Users may obtain tailored lists of asteroid properties for any subset of asteroids or output files which are suitable for plotting spectral data on individual asteroids. The program has online help as well as user and programmer documentation manuals. The SOARD already has provided data to fulfill requests by members of the astronomical community. The SOARD continues to grow as data is added to the database and new features are added to the program. Author

N91-24392# M L Energia, Inc., Princeton, NJ.

INFRARED MULTIPHOTON IGNITION AND COMBUSTION ENHANCEMENT OF NATURAL GAS Final Report, Feb. 1988 - May 1989

M. Lavid and A. T. Poulos 14 Aug. 1990 96 p

(Contract GRI-5087-234-1580)

(PB91-144584; GRI-90/0227) Avail: NTIS HC/MF A05 CSCL 21B

This phase 1 feasibility study demonstrated the potential of using infrared multiphoton (IRMP) processes for ignition and combustion enhancement of natural gas. Experiments with IR lasers were conducted to investigate the effects of IRMP techniques on methane, ethane, isotopically substituted surrogates, and sensitized mixtures. Major findings include: (1) identification of HF/DF laser as an appropriate source for IRMP; (2) demonstration of IRMP decomposition of deuterated methane with a CO2 laser; (3) successful IRMP ignition of deuterated methane and ethane mixtures; and (4) successful IRMP ignition of methane mixtures using photosensitizers. These experimental findings support the concept that IRMP processes are capable of dissociating methane, other minor constituents of natural gas, or sensitizers to reactive, combustion enhancing radicals. A comprehensive phase 2 contract to bring the concept closer to commercial implementation is underway. GRA

N91-24393# Texas Univ., Austin.

STRUCTURE AND PROPERTIES OF NOVEL COMPOUNDS OF SILICON, GERMANIUM, AND TIN Final Report, 1 Oct. 1986 - 30 Sep. 1990

Josef Michl Jan. 1991 8 p

(Grant AF-AFOSR-0001-87; AF Proj. 2303)

(AD-A232892; AFOSR-91-0173TR) Avail: NTIS HC/MF A02 CSCL 07/4

Efforts were concentrated on the spectroscopy, photophysics, and photochemistry of polysilanes, using a combination of experimental and theoretical tools. A more detailed version of the chain segment model was developed, the persistent radical formed in UV photolysis was identified and thoroughly characterized, the recently uncovered process of photoinduced chain scission by reductive elimination was further documented, and the theoretical understanding of the electronic states of model short-chain oligosilanes advanced. The combined results suggest strongly that the shorter chromophoric chain segments have a different lowest excited singlet state that the longer ones. GRA

N91-24394 Department of the Navy, Washington, DC.
MULTIPLEL CHANNEL AUTOMATIC CONCENTRATION METER Patent
Robert G. Howard, inventor (to Navy) and Edwin L. Zivi, Jr., inventor (to Navy) 15 Jan. 1991 9 p Filed 27 Jun. 1978
(AD-D014832; US-Patent-4,984,452; US-Patent-Appl-SN-921622; US-Patent-Class-73-61.3) Avail: US Patent and Trademark Office CSCL 14/2

This system measures the concentration level of additives dissolved or suspended in a liquid by measuring the changes which the additives cause to the heat transfer characteristics of the liquid. A plurality of cylinders and pistons sample the liquid to be measured and pump the samples past a hot film anemometer probe at a constant flow rate. A rigid of wires upstream from the hot film anemometer probe is used to cause isotropic turbulence in the liquid flow around the measuring probe is proportional to the rate at which heat is transferred away from the probe by the liquid flowing past. The rate at which heat is transferred away from the probe is a function of the specific heat, thermal conductivity, viscosity, and turbulent flow characteristics of the liquid which in turn are a function of the concentration level of additives in the liquid. Calibration curves for a given additives, liquid temperature and liquid flow rate are used to determine concentration level from the measurement probe output signal. GRA

N91-24395# Puerto Rico Univ., Rio Piedras. Dept. of Physics.
THE STRUCTURE OF ELECTROCHEMICAL ADSORBATES
J. G. Gordon and L. Blum 29 Jan. 1991 3 p
(AD-A232991; TR-7) Avail: NTIS HC/MF A01 CSCL 07/4

The X ray absorption spectrum was attempted at the bromine edge of a submonolayer of bromide ion adsorbed electrochemically on an Ag(III) surface. During the experiment, the silver electrode was immersed in solution and held at controlled electrochemical potential. Grazing incidence excitation was used with fluorescence detection. A clear edge jump was observed, but with the available collection time, the resulting spectra did not have a good enough signal-to-noise to be useable. GRA

N91-24396# Puerto Rico Univ., Rio Piedras. Dept. of Physics.
EXACT RESULTS FOR THE STRUCTURED LIQUID-SOLID INTERFACE
L. Blum and D. A. Huckaby 29 Jan. 1991 11 p
(AD-A232992; TR-2) Avail: NTIS HC/MF A03 CSCL 07/4

The theoretical discussion of smooth surfaces is considerably simpler than that of a realistic surface, in which the solid, usually a metal, has a well defined crystal structure. The reason is that in the case of a smooth surface the problem is 1-D, rather than 3-D. The analysis of a realistic metal surface potential in contact with an ionic solution is extremely difficult, and requires the use of very large computers. A simple model is discussed of a structured interface which predicts surface phase behavior, for the adsorbed layers, and which is mathematically tractable. In fact, if the correlation functions of the smooth surface model are known to all orders, then the properties and correlation functions of the model can be computed exactly, at least in principle. GRA

N91-24397# Lyon-1 Univ. (France).
HIGH RESOLUTION SPECTROSCOPY OF NF AND BIF Final Report, 30 Sep. 1988 - 28 Sep. 1990
Roger Bacis 29 Sep. 1990 5 p
(Grant AF-AFOSR-0347-88)
(AD-A233032; EOARD-TR-91-04) Avail: NTIS HC/MF A01 CSCL 07/4

During the period covered by the U.S. Air Force grant a Broida type oven was constructed allowing the spectroscopic investigation of the A $O+$ and X $O+$ electronic states of the BiF molecule. Potential energy curves for the A and X states were constructed up to $v = 25$ and $v = 36$ respectively, much farther than previously known. Except a drastic change in the nature of the BiF (X $O+$) band strength, the dissociation energy is estimated 40 000 cm-1 almost twice the calculated current value. We are currently constructing a new BiF source in order to better determine the electronic structure of low-lying states of BiF. GRA

N91-24398# Ballistic Research Labs., Aberdeen Proving Ground, MD.
MICROEMULSION OF MOLTEN SALTS Final Report, Sep. 1988 - Aug. 1989
Do R. Chang Feb. 1991 28 p
(AD-A233054; BRL-CR-653) Avail: NTIS HC/MF A03 CSCL 07/4

A non-aqueous, microemulsion system, consisting of molten salts with sodium dodecyl sulfate (SDS), 1-pentanol, and decane, was studied with electrical-conductivity measurements in the molten salt-rich emulsion phase. The molten salts are a nitrate mixture of ethylenediamine/ammonium/potassium of 50/42.5/7.5 by weight, respectively. The continued addition of alcohol to a fixed ratio of salts/surfactant/oil initially causes the conductivity to decrease and then to rise again, and the solution exhibits a change from turbid to clear to increasing turbidity. This may indicate a structural change from a globular droplet to a bi-continuous microemulsion form. Other properties of microemulsions related to these measurements will be discussed. GRA

N91-24399# Waterloo Univ. (Ontario). Dept. of Chemistry.
ADSORPTION OF PYRIDINE AT THE Au(111)-SOLUTION INTERERFACE Technical Report No. 17, Aug. - Dec. 1990
L. Stolberg, S. Morin, J. Lipkowski, and D. E. Irish 15 Feb. 1991 49 p
(Contract N00014-87-J-1118)
(AD-A233347) Avail: NTIS HC/MF A03 CSCL 07/2

The energetics of pyridine adsorption onto an Au(111) single crystal electrode surface were characterized using chronocoulometry. The adsorption parameters such as the relative Gibbs surface excesses, the Gibbs energies of adsorption, and electrosorption valencies were determined as a function of the electrode potential and surface charge density. Over the potential region investigated (-0.8 to +0.6 V) pyridine was found to adsorb in two different orientations. The flat orientation is observed on the negatively charged electrode surface while the vertical orientation is present on the positively charged surface. Reorientation between the flat and the vertical orientations takes the form of a 2-D phase transition. . GRA

N91-24400# Cincinnati Univ., OH. Dept. of Materials Science and Engineering.
CHARACTERIZATION OF INTERPHASES BETWEEN PMDA/4-BDAF POLYIMIDES AND SILVER SUBSTRATES USING SURFACE-ENHANCED RAMAN SCATTERING AND REFLECTION-ABSORPTION INFRARED SPECTROSCOPY
W. H. Tsai and F. J. Boerio 15 Mar. 1990 38 p
(Contract N00014-89-J-1590)
(AD-A233531; TR-12) Avail: NTIS HC/MF A03 CSCL 20/5

Surface-enhanced Raman scattering (SERS) and reflection-absorption infrared spectroscopy (RAIR) were used to determine the molecular structure of interphases formed by curing the polyamic acid of pyromellitic dianhydride (PMDA) and 2,2-bis (4-(4-aminophenoxy) phenyl) hexafluoro propane (4-BDAF) against silver substrates. SERS spectra of the cured polymer were more simular to the SERS spectra of the polyamic acid than to the normal Raman spectrum of the polymide, indicating that curing of the polymer was inhibited by interaction of the polyamic acid with the substrate. Thus, the strongest band in the normal Raman spectrum of the polymide was near 1406 /cm and was assigned to the CNC axial stretching mode. GRA

N91-24401# Delaware Univ., Newark. Center for Catalytic Science and Technology.
DESIGN OF A HIGH ACTIVITY AND SELECTIVITY ALCOHOL CATALYST
H. C. Foley and G. A. Mills Mar. 1991 4 p
(Contract DE-FG22-90PC-90291)
(DE91-010344; DOE/PC-90291/T2) Avail: NTIS HC/MF A01

During the second quarter the project focussed upon the design

and construction of various pieces of equipment to be used in the service of this program. First, as part of the research the authors will be using chemisorption of metal carbonyl complexes on the surface of alumina support media as a means to the synthesis of highly dispersed, bimetallic catalysts consisting of rhodium and molybdenum oxides, as well as other metals. These steps involve reacting the support surface under inert conditions with the precursor compound. During this time they have assembled an ACE-Burlitch inert atmosphere system. This system, coupled with a model 2008AC Alcatel mechanical vacuum pump, provides the essential dry, oxygen-free nitrogen and light vacuum service (down to 5 x 10(exp -4) torr) needed for the air-sensitive chemistries employed in the catalyst synthesis. A Manostate Glove Box (Aldrich Z16,994-3), which will be maintained with dry argon, has been installed for the handling and storage of catalyst samples. The third effort during this quarter focussed upon installing and bringing on-line a low-pressure flow reactor for catalytic investigations, aimed, especially, at the generation of fundamental kinetics data for structure-activity relationships. A flow sheet for the system is attached. The system has been augmented with a Hewlett-Packard model 5710 gas chromatograph equipped with a flame ionization detector and a model 3890 integrator. This instrumentation is currently being calibrated for the first reactor experiments. The first reactor experiments will focus upon a simple model reaction-methanol dehydration to dimethyl ether. DOE

N91-25024*# TRW Space and Defense Sector, Redondo Beach, CA.
LEO SPACE ENVIRONMENTAL EFFECTS: TRW LDEF EXPERIMENTAL TRAYS Abstract Only
B. K. Blakkolb, J. Y. Yaung, L. E. Ryan, and W. Taylor *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 57 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 07D

N91-25025*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
INTERACTIONS OF ATOMIC OXYGEN WITH MATERIAL SURFACES IN LOW EARTH ORBIT: PRELIMINARY RESULTS FROM EXPERIMENT A0114 Abstract Only
John C. Gregory, L. Christl, G. N. Raikar, J. J. Weimer, R. Wiser (Alabama Univ., Huntsville.), and P. N. Peters *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 58 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 07D

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

N91-24402*# Martin Marietta Labs., Baltimore, MD.
THE MECHANISMS OF DISPERSION STRENGTHENING AND FRACTURE IN Al-BASED XD(TM) ALLOYS, PART 1 Final Report
R. M. Aikin, Jr. Washington NASA Sep. 1990 153 p (Contract NAS1-18531)
(NASA-CR-4365; NAS 1.26:4365; MML-TR-63C) Avail: NTIS HC/MF A08 CSCL 11F

The influence of reinforcement size, volume fraction, and matrix deformation behavior on room and elevated temperature strength; the fracture toughness; and the fatigue crack growth rate of metal matrix composites of Al-4(pct)Cu-1.5(pct)Mg with TiB2 were examined. The influence of reinforcement volume fraction was also examined for pure aluminum with TiB2. Higher TiB2 volume fractions increased the tensile yield strength at both room and elevated temperatures, and reduced the elongation to fracture. Tensile tests also indicate that small particles provided a greater increase in strength for a given volume fraction than larger particles, whereas elongation to fracture appeared to be insensitive to reinforcement size. Interparticle spacing appears to be the factor that controls the strength of these alloys, with the exact nature of the dependence relying on the nature of dislocation slip in the matrix (planar vs. diffuse). The isothermal aging response of the precipitation strengthened Al-4(pct)Cu-1.5(pct)Mg alloys was not accelerated by the presence of TiB2. Cold work prior to artificial aging created additional geometrically necessary dislocations which serve as heterogeneous nucleation sites leading to accelerated aging, a finer precipitate size, and an increase in the strength of the alloy. Author

N91-24403# National Inst. of Standards and Technology, Gaithersburg, MD. Metallurgy Div.
INSTITUTE FOR MATERIALS SCIENCE AND ENGINEERING: METALLURGY DIVISION, TECHNICAL ACTIVITIES 1990 Annual Report, 1 Oct. 1989 - 30 Sep. 1990
E. Neville Pugh and John H. Smith Sep. 1990 142 p (PB91-132225; NISTIR-4397) Avail: NTIS HC/MF A07 CSCL 11F

The FY 1990 activities of the Metallurgy Division of the National Institute of Standards and Technology (NIST) are summarized. These activities center upon the structure-processing-properties relations of metals and alloys and on methods of measurement; and also include the generation and evaluation of critical material data. Efforts comprise studies of metals processing and process sensors; advanced materials, including metal matrix composites, intermetallic alloys and superconductors; corrosion and electrodeposition; mechanical properties; magnetic materials; and high temperature reactions. Author

N91-24404*# Martin Marietta Labs., Baltimore, MD.
EVALUATION OF THE MICROSTRUCTURE OF Al-Cu-Li-Ag-Mg WELDALITE (TM) ALLOYS, PART 4 Final Report, Jun. 1989 - Oct. 1990
Joseph R. Pickens, K. S. Kumar, S. A. Brown, and Frank W. Gayle Washington NASA May 1991 108 p (Contract NAS1-18531)
(NASA-CR-4368; NAS 1.26:4368; MML-TR-90-69C-Pt-4) Avail: NTIS HC/MF A06 CSCL 11F

Weldalite (trademark) 049 is an Al-Cu-Li-Ag-Mg alloy designed to have ultrahigh strength and to serve in aerospace applications. The alloy displays significantly higher strength than competitive alloys in both naturally aged and artificially aged tempers. The strengthening phases in such tempers have been identified to, in part, explain the mechanical properties attained. In general, the alloy is strengthened by delta prime Al3Li and Guinier-Preston (GP) zones in the naturally aged tempers. In artificially aged tempers in slightly underaged conditions, strengthening is provided by several phases including GP zones, theta prime Al2Cu, S prime Al2CuMg, T(sub 1) Al2CuLi, and possibly a new phase. In the peak strength artificially aged tempers, T(sub 1) is the predominant strengthening phase. For individual titles, see N91-24405 through N91-24409.

N91-24405*# Martin Marietta Labs., Baltimore, MD.
NATURAL AGING AND REVERSION BEHAVIOR OF Al-Cu-Li-Ag-Mg ALLOY WELDALITE (TM) 049
Frank W. Gayle, Frank H. Heubaum, and Joseph R. Pickens *In its* Evaluation of the Microstructure of Al-Cu-Li-Ag-Mg Weldalite (tm) Alloys, Part 4 May 1991 p 12-26 (For primary document see N91-24404 16-26)
Avail: NTIS HC/MF A06 CSCL 11F

This study was initiated to understand the natural aging and reversion behavior of Weldalite (trademark) 049 in tempers without cold work. Of particular interest are: (1) the microstructural basis for the high strength in the T4 condition; (2) an explanation of the reversion phenomenon; and (3) the effect of re-aging at room temperature after a reversion treatment. Mechanical properties were measured and transmission electron microscopy (TEM) analysis performed at various stages of microstructural development during aging, reversion, and subsequent re-aging. Author

N91-24406*# Martin Marietta Labs., Baltimore, MD.
STRUCTURE AND PROPERTIES DURING AGING OF AN Al-Cu-Li-Ag-Mg ALLOY, WELDALITE (TM) 049
Frank W. Gayle, Frank H. Heubaum, and Joseph R. Pickens *In its* Evaluation of the Microstructure of Al-Cu-Li-Ag-Mg Weldalite (tm) Alloys, Part 4 May 1991 p 27-40 Sponsored in part by National Inst. of Standards and Technology (For primary document see N91-24404 16-26)
Avail: NTIS HC/MF A06 CSCL 11F

An Al-Cu-Li-Ag-Mg alloy, Weldalite (trademark) 049, was recently introduced as an ultra-high strength alloy (7000 MPa yield strength in artificially aged tempers) with good weldability. In addition, the alloy exhibits an extraordinary natural aging response (440 MPa yield strength (YS) in the unstretch condition) and a high ductility reversion condition which may be useful as a cold-forming temper. In contrast to other Al-Li alloys, these properties can essentially be obtained with or without a stretch or other coldworking operation prior to aging. Preliminary studies have revealed that the T4 temper (no stretch, natural age) is strengthened by a combination of GP zones and delta prime (Al3Li). The T6 temper (no stretch, aged at 180 C to peak strength) was reported to be strengthened primarily by T(sub 1) phase (Al2CuLi) with a minor presence of a theta prime like (Al2Cu) phase. On the other hand, a similar but lower solute containing alloy was reported to contain omega, (stoichiometry unknown), theta prime, and S prime in the peak strength condition. The purpose of this study is to further elucidate the strengthening phases in Weldalite (trademark) 049 in the unstretched tempers, and to follow the development of the microstructure from the T4 temper through reversion (180 C for 5 to 45 minutes) to the T6 temper. Author

N91-24407*# Martin Marietta Labs., Baltimore, MD.
EFFECT OF A PRIOR STRETCH ON THE AGING RESPONSE OF AN Al-Cu-Li-Ag-Mg-Zr ALLOY
K. S. Kumar, S. A. Brown, and Joseph R. Pickens *In its* Evaluation of the Microstructure of Al-Cu-Li-Ag-Mg Weldalite (tm) Alloys, Part 4 May 1991 p 41-54 (For primary document see N91-24404 16-26)
Avail: NTIS HC/MF A06 CSCL 11F

Recently, a family of Al-Cu-Li alloys containing minor amounts of Ag, Mg, and Zr and having desirable combinations of strength and toughness were developed. The Weldalite (trademark) alloys exhibit a unique characteristic in that with or without a prior stretch, they obtain significant strength-ductility combinations upon natural and artificial aging. The ultra-high strength (approximately 690 MPa yield strength) in the peak-aged tempers (T6 and T8) were primarily attributed to the extremely fine T(sub 1) (Al2CuLi) or T(sub 1)-type precipitates that occur in these alloys during artificial aging, whereas the significant natural aging response observed is attributed to strengthening from delta prime (Al3Li) and GP zones. In recent work, the aging behavior of an Al-Cu-Li-Ag-Mg alloy without a prior stretch was followed microstructurally from the T4 to the T6 condition. Commercial extrusions, rolled plates, and sheets of Al-Cu-Li alloys are typically subjected to a stretching operation before artificial aging to straighten the extrusions and, more importantly, introduce dislocations to simulate precipitation of strengthening phases such as T(sub 1) by providing relatively low-energy nucleation sites. The goals of this study are to examine the microstructure that evolves during aging of an alloy that was stretch after solution treatment and to compare the observations with those for the unstretched alloy. Author

N91-24408*# Martin Marietta Labs., Baltimore, MD.
MICROSTRUCTURAL EVOLUTION DURING AGING OF AN Al-Cu-Li-Ag-Mg-Zr ALLOY
K. S. Kumar, S. A. Brown, and Joseph R. Pickens *In its* Evaluation of the Microstructure of Al-Cu-Li-Ag-Mg Weldalite (tm) Alloys, Part 4 May 1991 p 55-88 (For primary document see N91-24404 16-26)
Avail: NTIS HC/MF A06 CSCL 11F

Alloys in the Al-Cu-Li Ag-Mg subsystem were developed that exhibit desirable combinations of strength and ductility. These Weldalite (trademark) alloys, are unique for Al-Cu-Li alloys in that with or without a prior cold stretching operation, they obtain excellent strength-ductility combinations upon natural and artificial aging. This is significant because it enables complex, near-net shape products such as forgings and super plastically formed parts to be heat treated to ultra-high strengths. On the other hand, commercial extrusions, rolled plates and sheets of other Al-Cu-Li alloys are typically subjected to a cold stretching operation before artificial aging to the highest strength tempers to introduce dislocations that provide low-energy nucleation sites for strengthening precipitates such as the T(sub 1) phase. The variation in yield strength (YS) with Li content in the near-peak aged condition for these Weldalite (trademark) alloys and the associated microstructures were examined, and the results are discussed. Author

N91-24409*# Martin Marietta Labs., Baltimore, MD.
HIGH RESOLUTION ELECTRON MICROSCOPY STUDY OF A HIGH Cu VARIANT OF WELDALITE (TM) 049 AND A HIGH STRENGTH Al-Cu-Ag-Mg-Zr ALLOY
R. A. Herring, Frank W. Gayle, and Joseph R. Pickens *In its* Evaluation of the Microstructure of Al-Cu-Li-Ag-Mg Weldalite (tm) Alloys, Part 4 May 1991 p 89-103 Sponsored in part by National Inst. of Standards and Technology (For primary document see N91-24404 16-26)
Avail: NTIS HC/MF A06 CSCL 11F

Weldalite (trademark) 049 is an Al-Cu-Li-Ag-Mg alloy that is strengthened in artificially aged tempers primarily by very thin plate-like precipitates lying on the set of (111) matrix planes. This precipitate might be expected to be the T(sub 1) phase, Al2CuLi, which has been observed in Al-Cu-Li alloys. However, in several ways this precipitate is similar to the omega phase which also appears as the set of (111) planes plates and is found in Al-Cu-Ag-Mg alloys. The study was undertaken to identify the set of (111) planes precipitate or precipitates in Weldalite (trademark) 049 in the T8 (stretched and artificially aged) temper, and to determine whether T(sub 1), omega, or some other phase is primarily responsible for the high strength (i.e., 700 MPa tensile strength) in this Al-Cu-Li-Ag-Mg alloy. Author

N91-24410# Martin Marietta Labs., Baltimore, MD.
A STUDY OF THE INFLUENCE OF ALLOYING ADDITIONS ON THE PASSIVITY OF ALUMINUM Annual Report, 1 Dec. 1989 - 30 Nov. 1990
G. D. Davis, T. L. Fritz, B. J. Rees, B. A. Shaw, and W. C. Moshier 1 Mar. 1991 60 p
(Contract N00014-85-C-0638)
(AD-A232965; MML-TR-91-10C) Avail: NTIS HC/MF A04 CSCL 11/6

Whereas supersaturated aluminum alloys demonstrate enhanced passivity, conventional aluminum alloys spontaneously pit in air-saturated chloride solutions. We have concentrated on three areas: evaluation and characterization of Al-W alloys, which exhibit the best corrosion performance of any alloy system studied to date; characterization of the passive-film structure of Al-Mo alloys; and production and characterization of Al-W and Al-Ta powders, which will be used for compaction into bulk material. Surface analysis of the Al-W passive films formed during polarization show surprising little oxidized solute compared to other alloys. These results indicate that the barrier layer formation and electrostatic repulsion mechanisms used to explain the passivity of other alloys are not involved here. Instead the W may act to stabilize the passive film structure in a way similar to the way Molybdenum acts in Al-Mo alloys. That is oxidized molybdenum reduces the concentration of unstable tetrahedrally coordinated atomic sites. Finally, characterization of Al-Ta and Al-W powders indicate that some solute precipitates, but most remains in solid solution. Although such precipitation degrades passivity in cosputter-deposited alloys, the alloys still exhibit superior passivity compared to conventional materials. GRA

N91-24411# Lockheed Missiles and Space Co., Palo Alto, CA.
HIGH TEMPERATURE INTERACTIONS OF METALLIC MATRICES WITH CERAMIC REINFORCEMENTS Annual Report, 1 Jan. - 31 Dec. 1990
A. Joshi, T. C. Chou, and J. Wadsworth 31 Dec. 1990 80 p
(Contract F49620-88-C-0021)
(AD-A232967; LMSC-F404864; AFOSR-91-0045TR) Avail: NTIS HC/MF A05 CSCL 09/1

Interfacial reactions of SiC with selected high temperature metals have been studied at temperatures between 800 and 1200 C for various times. The metals include Nb, a strong carbide former, Co, Ni, Pt, and stainless steel. Reactions of the metals with SiC in this temperature range were extensive; various metal silicides, metal carbides, ternary metal-silicon-carbides, and unreacted carbon were formed as layered reaction products in the reaction zones. Thin films of Al2O3 in the 100 to 500 nm thickness range are shown to be effective in minimizing the reaction between Nb and SiC. In some system, massive or localized interfacial melting was observed as a result of metal-silicide formation. GRA

N91-24412# Pennsylvania State Univ., University Park. Dept. of Materials Science and Engineering.
HYDROGEN ASSISTED CRACKING AND CORROSION OF SOME HIGHLY CORROSION RESISTANT ALLOYS Report, for 15 Dec. 1983 - 30 Sep. 1990
Howard W. Pickering 1990 46 p
(Contract N00014-84-K-0201)
(AD-A233193) Avail: NTIS HC/MF A03 CSCL 11/6

Project goals in this study focused on localized corrosion and hydrogen embrittlement. The former emphasized grain boundary and crevice corrosion. Research on the latter has improved understanding of the intrusion of hydrogen into metals and an improved capability of preventing hydrogen assisted cracking of structural members. Results have been obtained on hydrogen absorption from the gas phase using the scanning tunneling microscope (STM). These results, which characterize the absorption process at an atomic scale, provide the capability of STM for studying the H-material interaction. Another important advance is the development of a theoretical basis for hydrogen entry into a metal during cathodic charging from aqueous solution. Models enable previously unavailable parameters to be determined from steady state hydrogen permeation. As a result, application of the model can provide new diagnostic criteria for determining the role of various system parameters in modifying the rate of hydrogen entry. GRA

N91-24413# Memry Technologies, Inc., Norwalk, CT.
DEVELOPMENT OF HIGH DAMPING FERROUS SHAPE MEMORY ALLOYS Annual Report No. 1, FY-90
Ming H. Wu 1990 16 p
(Contract N00014-90-C-0076)
(AD-A233543) Avail: NTIS HC/MF A03 CSCL 11/6

Alloys which exhibit high damping have potential in applications for noise and vibration controls. The damping mechanism in these alloys is generally related to the hysterestic effect of microstructural interfacial motions. For example, damping in Fe-Cr-Al alloys is due to the stress induced motion of ferromagnetic domain boundaries. Shape memory alloys, such as Cu-Al-Ni, Cu-Zn-Al, and NiTi, also exhibit high damping due to the motion of martensitic interfaces which can be driven by the excitation stress. However, the mechanical properties of shape memory alloys are highly temperature dependent in the range of the martensitic transformation. The modulus of these alloys is also quite low in the martensitic state making them less suitable for structural applications. The shape memory effect has been observed in ferrous alloys including Fe-Mn, Fe-Ni and Fe-Al based alloys as well as Fe-Pt and Fe-Pd alloys. These alloys, exhibiting a less perfect shape memory effect than do conventional shape memory alloys, have certain characteristics, such as higher modulus, better thermal stability, and potentially lower cost, which could make them more suitable for structural damping applications. GRA

N91-24414# Dayton Univ., OH.
A DYNAMIC FAILURE MODEL FOR DUCTILE MATERIALS Final Report, Oct. 1988 - Aug. 1990
A. M. Rajendran, D. J. Grove, M. A. Dietenberger, and W. H. Cook Feb. 1991 108 p
(Contract F33615-86-C-5064)
(AD-A233600; UDR-TR-90-109; AFATL-TR-90-84) Avail: NTIS HC/MF A06 CSCL 11/6

This report presents a recently developed continuum mechanics based dynamic failure model for ductile metals. Ductile failure often initiates due to void nucleation and growth. The void generation degrades the strength and stiffness of the initially void-free material. Realistic mathematical models of this failure process requires an accurate description of the strain rate and temperature-dependent plastic flow in the intact material surrounding the microvoids. This is all the more important when the evolution law for ductile void growth is based on the plastic deformation in the intact material. An elastic perfectly plastic idealization of the intact material may lead to erroneous or sometimes limited applicability of the failure model. The present failure model incorporates a state variable based viscoplasticity theory into the model formulation. The nucleation of voids is modeled as a statistical process. A Gaussian function based on mean stress and/or strain threshold has been used in the failure model formulation. Model constants were determined for OFHC copper, Armco Iron, MAR-200, MAR-250, AF1410, C1008, and HY100 steels and tantalum. As a final exercise, the ductile failure processes in different geometrical configurations were described by the RDG model. GRA

N91-24415# Oak Ridge Y-12 Plant, TN.
GLOW DISCHARGE CLEANING AND VACUUM DEPOSITION OF COPPER ON 6061-T6 ALUMINUM
R. W. Vasofsky and W. D. Corbett, Jr. 25 Feb. 1991 19 p
(Contract DE-AC05-84OS-21400)
(DE91-009510; Y/DZ-707) Avail: NTIS HC/MF A03

Prior to plating electroless nickel onto a part made of 6061-T6 aluminum, several aqueous pretreatment steps are required which end with the deposition of a thin copper layer covering the part. In an effort to minimize the quantity and type of wastes generated during this pretreatment process, vacuum deposition methods are under evaluation as an alternative. Six vacuum cleaning/copper deposition experiments were conducted on 6061-T6 aluminum coupons. The coupons were glow discharge cleaned at 1500, 2000 and 2500 volts and a copper coating was either sputtered deposited or ion plated onto the aluminum substrate. The results showed that the adhesive strength of the copper coating was greatest for those coupons cleaned at 2500 volts and ion plated. Glow discharge cleaning was greatest for those coupons cleaned at 2500 volts and ion plated. Glow discharge cleaning at 1500 and 2000 volts resulted in copper films that were porous while those cleaned at 2500 volts were not. The results further showed that ion plated copper films of appropriate thickness can be produced while the aluminum alloy is precipitation hardened. DOE

N91-24416# Oak Ridge National Lab., TN.
ENVIRONMENTAL EMBRITTLEMENT OF IRON ALUMINIDES IN MOISTURE-CONTAINING ATMOSPHERES
C. G. McKamey and C. T. Liu 1991 15 p Presented at the 1st Symposium on Environmental Effects of Advanced Materials, San Diego, 19-21 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010149; CONF-9106145-1) Avail: NTIS HC/MF A03

A brief review is presented of recent research on the effect of test environment on room temperature tensile ductility and fracture in FeAl- and Fe3Al-based alloys. For more than forty years, iron aluminides have been known to be brittle at ambient temperatures; however, the cause of this brittleness was not identified until recently. The recent study of the mechanical properties of iron aluminides in controlled environments has revealed that brittle fracture and low ductility is probably caused by dynamic environmental embrittlement involving the dissociation of water molecules at the crack tip by aluminum atoms in the alloy and the release of atomic hydrogen. When tested in air,

FeAl (36.5 pct. Al) exhibited brittle cleavage fracture and a low ductility of 2.2 pct. at room temperature. The yield stress was found to be insensitive to environment, while the ductility was found to increase to as high as 17.6 pct. when tested in dry oxygen. The fact that the yield strength is insensitive to both ductility and test environment is consistent with the mechanisms of hydrogen embrittlement observed in other ordered intermetallic alloys. Testing in water vapor at gas pressures of 6.7 x 10(exp 4) Pa (500 torr) confirmed the low ductility found in air tests, indicating that water vapor is the embrittling agent in iron aluminides. Fe3Al also showed environmental embrittlement at room temperature, although the degree of sensitivity was less, presumably because of its lower aluminum concentration. Consistent with being a chemical effect, the environmental embrittlement in Fe3Al was found to be insensitive to whether it had the DO3 or B2 crystal structure. DOE

N91-24417# Cornell Univ., Ithaca, NY. Lab. of Atomic and Solid State Physics.
FOCAL THEORETICAL PROBLEMS IN MODULATED AND MARTENSITIC TRANSFORMATIONS IN ALLOYS AND PEROVSKITES
J. A. Krumhansl 1991 10 p
(Contract DE-FG02-88ER-45364)
(DE91-010610; DOE/ER-45364/2) Avail: NTIS HC/MF A02

Fundamental understanding of the microscopic physics of displacive transformations requires insight into the most remarkable and fascinating feature common to so many of the transformations; the formation of local distortive structures, modulations and more general patterns at the mesoscopic scale, far larger than atomic spacings, much smaller than typical specimen size. These have been extensively studied by metallurgists for some time; but also, they are are manifest in ferroelectrics, in such phenomena as the blue phases in cholesteric liquid crystals, and in turbulence. This commonality in such a wide range of materials challenges us to achieve a basic understanding of the physics of why such local, persistent mesostructures appear. In order to address some of the bigger questions - microscopics of nucleation and growth, mesoscopic and transitional (precursor) structures, and properties of transformed materials - we began addressing the limitations of traditional methods for describing the thermodynamics and (elastic) distortions of displacive transformations. Conventional phonon descriptions and linear elasticity (and their contribution of the free energy) are obviously limited to very small distortions and are intrinsically incapable of describing the larger, topology changing displacements that are of essence here. DOE

N91-24418# General Electric Co., Schenectady, NY. Atomic Power Lab.
THE MICROSTRUCTURE AND TENSILE PROPERTIES OF NITROGEN CONTAINING VACUUM ATOMIZED ALLOY 690
G. E. Fuchs and S. Z. Hayden Feb. 1991 13 p
(Contract DE-AC12-76SN-00052)
(DE91-010695; KAPL-4722) Avail: NTIS HC/MF A03

The mechanical properties and microstructure of a heat of nitrogen containing vacuum atomized A690 have been characterized. Although wrought A690 exhibits extensive grain growth during solution annealing heat treatments, only limited grain growth was observed in P/M690N2. The presence of the nitrogen in the P/M690N2 resulted in the formation of a fine dispersion of Ti(C,N) which limited grain growth during elevated temperature exposures. The yield and ultimate tensile strength of the P/M690N2 was significantly greater than wrought A690 and elevated temperature exposures did not greatly affect the properties of the P/M690N2. Although the P/M690N2 did exhibit appreciably higher strengths than wrought A690, the ductility was not adversely affected. In general, the resulting microstructure and, hence, mechanical properties of the P/M690N2 were very stable, uniform, and reproducible, even after long-term elevated temperature exposures of up to 24 hours at 1100 C. DOE

N91-24419# Pacific Northwest Lab., Richland, WA.
TEMPERATURE EFFECTS ON THE STRENGTH AND TOUGHNESS OF Be12Nb
S. M. Bruemmer, B. W. Arey, C. H. Henager, Jr., and R. E. Jacobson (Washington State Univ., Pullman.) Nov. 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, 24 Nov. - 1 Dec. 1990
(Contract DE-AC06-76RL-01830)
(DE91-010838; PNL-SA-18654; CONF-901105-117) Avail: NTIS HC/MF A02

Strength and toughness of single-phase Be12Nb has been assessed at temperatures from ambient to 1200 C using four-point bend and hardness tests. Vacuum-hot-pressed beryllide exhibits low bend strengths and fracture toughnesses at temperatures up to 500 C. Measured bend strength then increases to maximum at 100 C, while K(sub IC) slowly increases through 110 C. Significant plastic deformation is only observed at 1200 C for the test strain rate of 3 x 10(exp -4)/s. Hardness values were found to remain relatively constant at temperatures up to 800 C and then sharply decrease at higher temperatures. Results indicate that low toughness limits bend strength at temperatures below 1000 C and prompts the observed increase in strength at high temperatures. DOE

N91-24420# Oak Ridge National Lab., TN.
HIGH-TEMPERATURE ORDERED INTERMETALLIC ALLOYS
C. T. Liu 10 Apr. 1991 20 p
(Contract DE-AC05-84OR-21400)
(DE91-010927; ORNL/FTR-3882) Avail: NTIS HC/MF A03

The traveler was invited to tour through and provide technical guidance for the Japan National Project on High-Temperature Ordered Intermetallic Alloys, which was sponsored by MITI, Japan. The traveler stayed in Japan for three weeks and visited a total of nine research institutes and industrial laboratories active in intermetallic research. During the visit, the traveler learned of the recent research and development of two intermetallic model materials - titanium aluminide (TiAl) and niobium aluminide (Nb3Al) selected by MITI. The traveler also gave lectures on recent advances in ordered intermetallic alloys with emphasis on brittle fracture and ductility improvement. The MITI's project has provided leadership and stimulated interest in intermetallic research and development among Japan industries. DOE

N91-24421# Gandhi (Indira) Centre for Atomic Research, Kalpakkam (India).
COMPATIBILITY STUDIES OF COPPER, BRASS AND CUPRONICKEL WITH HYTHERM-500 THERMOFLUID
M. G. Pujar, R. K. Dayal, and J. B. Gnanamoorthy 1989 11 p
(DE91-618664; IGC-107) Avail: NTIS HC/MF A03

Carbon steel used as a structural material in thermofluid/water heat exchangers in the Fast Breeder Test Reactor (FBTR) got perforated resulting in leakage. To suggest an alternative better corrosion resistant material for these exchangers, corrosion resistance studies of copper based alloy systems in both as-received and pickled conditions were carried out in the thermofluid medium (Hytherm-500) at room temperature (approximately 298 K), 373, and 423 K for up to a 500 hour duration. The tested materials, copper, admiralty brass, and 70/30 cupronickel were found to have excellent corrosion resistance in both as-received and pickled conditions. In all the cases, corrosion rates decreased with increased duration of exposure. All the above materials showed better corrosion resistance in pickled condition compared to that in as-received condition. The relative corrosion resistance of these three alloys was as follows: admiralty brass greater than copper and copper greater than cupronickel. This trend in the corrosion resistance was observed in both as-received and pickled conditions. In general, the corrosion resistance in pickled condition was found to be better than that in as-recieved condition. DOE

N91-24422# California Univ., Berkeley. Lawrence Berkeley Lab.
NOVEL METAL ION SURFACE MODIFICATION TECHNIQUE

I. G. Brown, X. Godechot, and K. M. Yu Oct. 1990 9 p
(Contract DE-AC03-76SF-00098)
(DE91-010228; LBL-29705) Avail: NTIS HC/MF A02

We describe a method for applying metal ions to the near-surface region of solid materials. The added species can be energetically implanted below the surface or built up as a surface film with an atomically mixed interface with the substrate; the metal ion species can be the same as the substrate species or different from it, and more than one kind of metal species can be applied, either simultaneously or sequentially. Surface structures can be fabricated, including coatings and thin films of single metals, tailored alloys, or metallic multilayers, and they can be implanted or added onto the surface and ion beam mixed. We report two simple demonstrations of the method: implantation of yttrium into a silicon substrate at a mean energy of 70 keV and a dose of 1 x 10(exp 16) atoms/sq cm, and the formation of a titanium-yttrium multilayer structure with ion beam mixing to the substrate. DOE

N91-24159# Wichita State Univ., KS.
THE EFFECT OF SURFACE GENERATED SCRATCHES ON THE FATIGUE LIFE OF AEROSPACE MATERIALS
Jorge E. Talia, Behnam Bahr, and Hamid M. Lankarani *In its* Program Plans for Aviation Safety Research Dec. 1990 6 p
(For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

N91-24312*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CUMULATIVE CREEP FATIGUE DAMAGE IN 316 STAINLESS STEEL
Michael A. McGaw *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 33-37 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11F

N91-24313*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FATIGUE BEHAVIOR OF A SINGLE-CRYSTAL SUPERALLOY
Sreeramesh Kalluri (Sverdrup Technology, Inc., Cleveland, OH.) and Michael A. McGaw *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 39-44 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11F

N91-24316*# Carnegie-Mellon Univ., Pittsburgh, PA.
THE EFFECT OF HYDROGEN ON THE DEFORMATION BEHAVIOR OF A SINGLE CRYSTAL NICKEL-BASE SUPERALLOY
W. S. Walston, A. W. Thompson, and I. M. Bernstein (Illinois Inst. of Tech., Chicago.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 59-66 Sponsored by NASA. Lewis Research Center (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11F

N91-24317*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
THE INFLUENCE OF ADVANCED PROCESSING ON PWA 1480
L. G. Fritzemeier and G. D. Schnittgrund *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 67-79 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 11F

N91-24366*# Arizona Univ., Tucson. Lunar and Planetary Lab.
COPRODUCTION OF VOLATILES AND METALS FROM EXTRATERRESTRIAL MATERIALS
John S. Lewis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 3 p
(For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 11F

N91-24379*# Arizona Univ., Tucson. Dept. of Chemistry.
RECOVERY OF PRECIOUS METALS FROM SPACE
Henry Freiser *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 14 p
(For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 11F

N91-25041*# Army Materials Technology Lab., Watertown, MA.
ELLIPSOMETRIC STUDY OF METAL SAMPLES Abstract Only
W. Franzen, Judy Brodkin, and Paul L. Sagalyn *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 74 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11F

N91-25042*# Boeing Aerospace and Electronics Co., Seattle, WA.
CONDITION OF CHROMIC ACID ANODIZED ALUMINUM CLAMPS FLOWN Abstract Only
W. L. Plagemann *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 75
(For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11F

27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

N91-24423 Cleveland State Univ., OH.
DEVELOPMENT OF AN ANALYTICAL-EXPERIMENTAL METHODOLOGY FOR PREDICTING THE LIFE AND MECHANICAL BEHAVIOR OF THERMAL BARRIER COATINGS Ph.D. Thesis
Woraphat Phucharoen 1990 188 p
Avail: Univ. Microfilms Order No. DA9100864

The state of the art plasma sprayed thermal barrier coating (TBC) is a two layer coating system. The inner layer is an oxidation resistant metallic bond coat (NiCrAlY), and the outer layer is an insulating ceramic material (zirconia-8 wt pct yttria). TBC will enable turbine components to operate at higher temperature and lower cooling gas flow rates; thereby improving efficiency. The objective was to develop a methodology to predict the life and mechanical behavior of TBC. The problem is a complex one due to layering, uneven interface between the ceramic layer and the bond coat, oxidation of the bond coat, thermal expansion mismatch, combined influence of plasticity in both ceramic and the bond coat, low tension properties of ceramic material, and temperature dependent properties of the bond coat. Thus, an effort was made to use the finite element method (FEM) to represent a cylindrical model TBC which resembles those that were lab tested. To implement the FEM scheme, a generic code called MARC was used with the aid of a supercomputer at NASA-Lewis. Numerical results were favorably correlated with the experimental results, which show that substrate yield strength and bond coat composition did not significantly influence the cracking behavior of TBC.

Dissert. Abstr.

N91-24424# Wichita State Univ., KS. National Inst. for Aviation Research.
CHARACTERIZATION OF ACETYLENE TERMINATED SULFONE (ATS) RESIN. PART 1: CHEMICAL CHARACTERIZATION OF THE RESIN
William T. K. Stevenson and I. J. Goldfarb (Wright State Univ., Dayton, OH.) Apr. 1991 46 p
(NIAR-91-6-Pt-1) Avail: NTIS HC/MF A03

An acetylene terminated sulfone resin mixture was subjected to a fairly extensive compositional analysis. Monomer, dimer, higher oligomers, solvents, and anomalous side products of synthesis were isolated, identified and quantified using separatory procedures such as column chromatography and thin film flash distillation, in

conjunction with techniques of chemical analysis such as IR and NMR spectroscopy, size exclusion chromatography, and elemental analysis. Author

N91-24425# Wichita State Univ., KS. National Inst. for Aviation Research.
CHARACTERIZATION OF ACETYLENE TERMINATED SULFONE (ATS) RESIN. PART 2: THERMAL ANALYSIS OF THE RESIN
William T. K. Stevenson, I. J. Goldfarb, E. J. Soloski, and M. J. Houtz (Dayton Univ. Research Inst., OH.) Apr. 1991 49 p
(NIAR-91-7-Pt-2) Avail: NTIS HC/MF A03

The kinetics and thermodynamics of the cure and post cure reactions of an acetylene terminated sulfone resin mixture and pure fractions from that mixture were studied using Differential Scanning Calorimetry. Thermal stabilities were measured by programmed thermogravimetry under helium, and oxidative stabilities using isothermal thermogravimetry in air. Microstructural changes accompanying the cure reaction were identified using IR spectroscopy. Early products of thermal degradation were trapped for identification and quantitative analysis using the technique of Sub Ambient Thermal Volatilization Analysis. Author

N91-24426*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
IMPROVED SPRAYABLE LIGHTWEIGHT ABLATIVE COATING Patent Application
William G. Simpson, inventor (to NASA), Max H. Sharpe, inventor (to NASA), and William E. Hill, inventor (to NASA) 28 Nov. 1990 8 p
(NASA-Case-MFS-28372-1; NAS 1.71:MFS-28372-1; US-Patent-Appl-SN-618854) Avail: NTIS HC/MF A02 CSCL 11C

An improved lightweight, ablative coating is disclosed that may be spray applied and cured without the development of appreciable shrinkage cracks. The ablative mixture consists essentially of phenolic microballoons, hollow glass spheres, glass fibers, ground cork, a flexibilized resin binder, and an activated colloidal clay. NASA

N91-24427# National Inst. of Standards and Technology, Gaithersburg, MD. Materials Science and Engineering Lab.
SECOND INDUSTRY WORKSHOP ON POLYMER COMPOSITE PROCESSING
Carl Johnson, Shu Sing Chang, and Donald Hunston Dec. 1990 87 p Workshop held in Gaithersburg, MD, 18 May 1990
(PB91-132191; NISTIR-4461) Avail: NTIS HC/MF A05 CSCL 11C

The most important processing methods, and scientific and technical barriers to improve polymer composite processing were identified. Two processing methods were selected as most important: pressure molding and liquid molding. The highest priority items are the need to understand and control resin flow and fiber orientation, to develop process monitoring sensors for on-line control, and to understand and control the fiber-matrix interface. The most important technologies that complement processing and are important for the future are fiber placement, new methods to prepare prepreg, and joining. Author

N91-24428 Georgia Inst. of Tech., Atlanta.
BOUNDARY ELEMENT METHODS FOR LINEAR AND NONLINEAR SOLID MECHANICS PROBLEMS; AND FRACTURE TOUGHNESS ENHANCEMENT MECHANISMS IN CERAMIC MATERIALS Ph.D. Thesis
Hiroshi Okada 1990 332 p
Avail: Univ. Microfilms Order No. DA9105455

The boundary element method is applied to the analyses of linear elasticity, small strain elastoplasticity, and large strain elastoplasticity. New non-hyper singular integral equations for the displacement (velocity) gradients are derived for small strain linear elasticity, small strain elastoplasticity, large strain semi-linear elasticity, and large strain elastoplasticity. The newly derived integral representations have one order lesser singularity than the conventional integral equations for the gradients, and is numerically tractable to compute the gradients at the boundary. By the use of these newly derived integral equations, the displacement gradients at the boundary of, as well as, at the interior of the body are accurately obtained. For the analysis of the problems, which contain plastic instabilities, a full tangent stiffness formulation of the field-boundary element method is proposed. Initially perfect tensile plate is analyzed. The bifurcation of the solution path is captured, and the post bifurcation diffused necking is successfully analyzed. The micromechanics of toughness enhancement mechanisms in certain ceramic materials is examined. Transformation toughening and microcracking were found to be very useful in enhancing the fracture toughness of ceramic composite materials. A nonlinear constitutive model for the transformation induced plasticity is presented. This nonlinear constitutive model is implemented in a nonlinear finite element method and applied to crack problems. Stationary cracks as well as stably propagating crack problems are analyzed to estimate the fracture toughness enhancement due to the transformation effect. The stress induced phase transformation has a significant effect on the enhancement of fracture toughness. In order to derive the constitutive equation, a self-consistent method is used. Dilatational irreversible strain, for the coupled microcracking-transformation case, as a function of volume fraction of transformed zirconia is also derived. Dissert. Abstr.

N91-24429 Pennsylvania State Univ., University Park.
A FINITE ELEMENT MODEL FOR THERMOCHEMICALLY DECOMPOSING POLYMERS Ph.D. Thesis
Roy Michael Sullivan 1990 188 p
Avail: Univ. Microfilms Order No. DA9104976

A finite element method is developed to analyze the themochemical decomposition of thermosetting polymers. This method models the accumulation and subsequent flow of the pyrolysis gases through the porous solid. It couples the equations of energy balance, mass transport, and motion and solves them simultaneously at each time step. The method is verified through a series of benchmark problems and the results obtained are in excellent agreement with the previously published results. It is then applied to the thermochemical decomposition of carbon phenolic through the restrained thermal growth test and the free thermal expansion test. The predicted results are in close agreement with the measured response for both tests. In addition, these models are used to investigate the significance of certain carbon phenolic properties. Dissert. Abstr.

N91-24430*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
EFFECTS OF WATER ON THE STRENGTH OF ZERODUR
Dennis S. Tucker and Andrew Setzer Apr. 1991 9 p
(NASA-TM-103535; NAS 1.15:103535) Avail: NTIS HC/MF A02 CSCL 11C

An experimental design matrix was constructed to determine the effects of time and temperature water soak on the strength of Zerodur glass-ceramic. It was found that strength does increase in a nonlinear manner which is consistent with existing theories of crack tip blunting and residual stress reduction. Author

N91-24431# National Inst. of Standards and Technology, Boulder, CO. Chemical Engineering Science Div.
THERMAL CONDUCTIVITY OF A POLYIMIDE FILM BETWEEN 4.2 AND 300 K, WITH AND WITHOUT ALUMINA PARTICLES AS FILLER
D. L. Rule, D. R. Smith, and L. L. Sparks Aug. 1990 77 p Sponsored by Ship Structure Committee, Washington
(PB91-144402; NISTIR-3948) Avail: NTIS HC/MF A05 CSCL 11C

The thermal conductivity of several types of commercial polyimide, polypyromellitimide (PPM), film was measured over a range of temperatures from 4.2 to 300 K using an unguarded steady-state parallel plate apparatus. Specimens were made by stacking multiple layers of film together. Conductive grease was used between layers of film to reduce thermal contact resistance.

Two specimens were made from two different types of neat (unadmixed) film with a thickness of 76 micrometers, and three specimens were made from films containing two different amounts of admixed alumina filler having thicknesses of 25 micrometers or 76 micrometers. The conductivity of PPMI film increases with the amount of alumina filler present. The thermal conductivity of specimens made from film of the same type but of different thickness is independent of film thickness, within the limits of experimental uncertainty. The thermal conductivity of a specimen subjected to a simulated curing process by being held at a temperature of 150 C for ninety minutes was indistinguishable from that of a similar, control specimen not subjected to such treatment. GRA

N91-24432# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
COMPATIBILIZATION OF BLENDS OF CRYSTALLIZABLE POLYBUTADIENE ISOMERS BY PRECIPITATION AND BY ADDITION OF AMORPHOUS DIBLOCK COPOLYMER
Moira M. Nir and Robert E. Cohen 15 Feb. 1991 5 p
(Contract N00014-91-J-1045)
(AD-A232071; TR-3) Avail: NTIS HC/MF A01 CSCL 07/1

A brief summary of the research on compatibilized polymer blends is presented. Of particular significance is the model system of crystallizable polybutadiene isomers: trans 1,4 polybutadiene and syndiotactic 1,2 polybutadiene. Appropriate blending procedures, rapid precipitation from solvent (sometimes in the presence of an amorphous 1,4/1,2 polybutadiene block copolymer) led to a family of blends with attractive mechanical behavior. GRA

N91-24433# Lehigh Univ., Bethlehem, PA. Materials Research Center.
STRENGTH AND TOUGHNESS OF TAILORED CERAMIC MICROSTRUCTURES Final Report, 1 Sep. 1987 - 31 Oct. 1990
M. P. Harmer, H. M. Chan, G. A. Miller, J. D. French, and C. J. Russo 30 Dec. 1990 127 p
(Grant AF-AFOSR-0396-87)
(AD-A232911; AFOSR-91-0164TR) Avail: NTIS HC/MF A07 CSCL 11/4

AFOSR project 87-0396 was undertaken to develop a detailed understanding of the link between microstructural variables and the strength and toughness of ceramic materials. A major emphasis of this effort has been developing approaches for producing multiphase ceramic microstructures with enhanced reliability i.e., elevated temperature microstructural stability and damage tolerance and/or room temperature flaw tolerance. Improvements in elevated temperature damage tolerance depend upon having a dual phase interconnected microstructure with more than 16 volume percent second phase. Our findings show that adding cubic zirconia to alumina improves damage tolerance in the that Al2O3 with 50 percent c-ZrO2 (AZ50) shows the same hardness yet appreciably less indentation damage than alumina at 1200 C and is very resistant to grain coarsening for up to 100 hours at 1650 C. Also, Al2O3 with 50 percent YAG (AY50) has twice the hardness of Al2O3 at 1200 C. GRA

N91-24434# Washington Univ., Seattle.
SYNTHESIS AND STUDY OF METALLONITRIDE COMPLEXES AND POLYMERS Final Report, 15 Sep. 1987 - 30 Aug. 1990
Nancy M. Doherty 20 Feb. 1991 9 p
(Grant AF-AFOSR-0362-87; AF Proj. 2303)
(AD-A232949; AFOSR-91-0178TR) Avail: NTIS HC/MF A02 CSCL 07/2

The synthesis and chemistry of compounds in which two transition metal centers are bridged by a single nitrogen atom, the bridging nitride, has been investigated. These studies have focused on understanding the chemical and physical properties of the M(N)M unit in order to explore its use as a building block for new. The approach to this chemistry has involved parallel exploration of molecular nitride-bridged species, which serve as model systems for developing the chemistry of these compounds, and of extended structures incorporating metal-nitrogen-metal linkages. Supporting studies on the preparation and reactivity of silylimido precursor compounds, which are used in the synthetic route to nitride-bridged structures, have also been performed. GRA

N91-24435# Virginia Polytechnic Inst. and State Univ., Blacksburg.
PROCESSING STUDIES OF BLENDS OF POLYPROPYLENE WITH LIQUID CRYSTALLINE POLYMERS
A. Datta, J. P. DeSouza, A. P. Sukhadia, and D. G. Baird Jan. 1991 20 p
(Contract DAAL03-88-K-0104)
(AD-A232961; ARO-25344.8-MS) Avail: NTIS HC/MF A03 CSCL 07/6

Several processing methods to improve the mechanical properties of polypropylene (PP) by blending them with liquid crystalline polymers (LCPs) have been investigated in this study. Injection molded plaques of PP blended with LCPs showed significant improvements in the modulus but not exhibit any increase in tensile strengths and had poor surface finish. Higher tensile strength and better surface finish were obtained by compatibilization of PP with LCP. Compatibilization was carried out by a reactive extrusion process in which PP was grafted to LCP and it also further enhanced the modulus of the PP/LCP blends. Finally the compatibilized and the non-compatibilized PP/LCP blended plaques were processed by solid phase forming techniques in which the composites were deformed after preheating them below the melting point of the LCPs. This led to substantial increase in their modulus while not altering their tensile strengths. GRA

N91-24436# Waterloo Univ. (Ontario). Dept. of Chemistry.
THE APPLICATION OF CONCENTRATION-DISTANCE PROFILING RAMAN MICROSPECTROSCOPY TO THE STUDY OF THE PHOTOINDUCED CRYSTALLIZATION OF TRIETHYLENEDIAMINE TRIIODIDE UPON A SILVER ELECTRODE Technical Report, Aug. - Dec. 1990
T. Ozeki and D. E. Irish 15 Feb. 1991 21 p
(Contract N00014-87-J-1118)
(AD-A233000; TR-19-ONR) Avail: NTIS HC/MF A03 CSCL 07/3

The technique of concentration-distance profiling Raman microspectroscopy has been applied to the system silver/triethylenediamine, HClO4, NaI, H2O to map out the variations in the concentrations of species with distance from the electrode surface. Under anodic conditions crystals of triethylenediamine triiodide grow from the site of laser illumination. These have also been studied; they extend some 200 um from the silver electrode surface with maximum population at about 40 microns. Under cathodic conditions the crystals are destroyed and the surface is covered with iodide interacting in an ion-parting fashion with diprotonated triethylenediamine, abbreviated DABCO-H22+. GRA

N91-24437# Texas A&M Univ., College Station. Mechanics and Materials Research Center.
DEFORMATION AND FRACTURE OF FIBER-REINFORCED CERAMIC COMPOSITES Final Technical Report, 1 Oct. 1989 - 31 Aug. 1990
Dec. 1990 29 p
(Grant AF-AFOSR-0028-90; AF Proj. 2302)
(AD-A233031; MM-27470-90-15; AFOSR-91-0194TR) Avail: NTIS HC/MF A03 CSCL 11/2

Theoretical work on crack and damage growth in ceramic composites is summarized. Micromechanical models for viscoelastic behavior and crack growth in ceramics with a viscous grain boundary phase are developed. The emphasis is on extending earlier work for the limiting cases of elastic or viscous behavior to realistic viscoelasticity. Relationships for creep functions and crack speed are derived. Predictions for creep of ceramics with growing microcracks are made and compared with some experimental data. A publication on delamination analysis is in the appendix. GRA

N91-24438# Columbia Univ., New York, NY. Dept. of Chemistry.
POLYMER SYNTHESES AND MECHANISMS OF POLYMERIZATION Final Report
Thomas J. Katz 18 Mar. 1991 6 p
(Contract N00014-79-C-0683)
(AD-A233034) Avail: NTIS HC/MF A02 CSCL 07/6

The major outcome of the research was the discovery that acetylenes induce metal-derivatives to initiate methatheses of olefins. This discovery provides a simple way to synthesize a variety of polymers from cyclic olefins. Research to demonstrate the mechanism by which acetylenes induce methatheses showed that polyacetylenes appear as a block at the start of polyalkenamer chains. The initiation of the olefin methathesis quenches the acetylene polymerization. The size of the block revealed for the first time how the reactivities toward metal-carbenes differ for acetylenes and alkenes. GRA

N91-24439# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
SIMULATIONS OF HIGH-RATE DIAMOND SYNTHESIS: METHYL AS GROWTH SPECIES
D. G. Goodwin 28 Feb. 1991 17 p
(Contract N00014-90-J-1386)
(AD-A233079; TR-3) Avail: NTIS HC/MF A03 CSCL 08/7

The results of numerical simulations of two high-rate diamond growth environments (oxygen-acetylene torch and DC arcjet) are reported. The calculations account in detail for boundary-layer transport, gas chemistry, and gas-surface chemistry. Diamond growth rates are calculated self-consistently with the gas-phase concentrations, using a recently-proposed methyl growth mechanism. The calculated growth rates agree well with the measured values, indicating that this growth mechanism can account for both high and low-rate diamond growth. GRA

N91-24440# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
METHOD OF OBTAINING POLYMERIC CURRENT-CONDUCTING MATERIAL
V. Ye. Gul and N. F. Shchibrya 26 Oct. 1990 6 p Transl. into ENGLISH from Russian Patent No. 246708 (20 Jun. 1969) p 1
(AD-A233129; FTD-ID(RS)T-0954-90) Avail: NTIS HC/MF A02 CSCL 07/6

Methods of obtaining isotropic polymeric current conducting materials by introduction to polymer of ferromagnetic filler with afterhardening in magnetic field are known. For purpose of obtaining anisotropic material with dibasic orientated structure, using proposed method solidification is accomplished in moving magnetic field. A polymeric composition is prepared with the dispersion of ferromagnetic filler for the bonding agents. A 45.6 d of nickel of carbonyl, 46.7 d 23 pct. solution is used of the partially saponified copolymer of vinyl acetate with the vinyl chloride of brand A-15-0 in the mixture of organic solvents, 7.7 g DGU (50 pct. solution of diethyleneglycolurethane in cyclohexanone). GRA

N91-24441# Rutgers - The State Univ., New Brunswick, NJ.
FRENCH-AMERICAN STRUCTURAL CERAMICS ROUNDTABLE Final Report
Jack Wenzel 23 Jan. 1991 17 p Presented at the Technical Meeting on Advanced Structural Ceramics, New Brunswick, NJ, 14 Dec. 1989
(Grant AF-AFOSR-0319-90)
(AD-A233146; AFOSR-91-0213TR) Avail: NTIS HC/MF A03 CSCL 11/2

Rutgers University hosted a one-day French-American technical meeting on advanced structural ceramics. Participants included seven French researchers and eight U.S. researchers from government, academia, and industry. Each participant discussed his home research institution from several view points: research themes, research capabilities, and technology transfer. GRA

N91-24442# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry.
POTENTIAL DEPENDENCE OF THE CONDUCTIVITY OF POLYACETYLENE: FINITE POTENTIAL WINDOW OF HIGH CONDUCTIVITY
David Ofer, Lee Y. Park, Richard R. Schrock, and Mark S. Wrighton Mar. 1991 14 p
(Contract N00014-84-K-0553)
(AD-A233263; TR-44) Avail: NTIS HC/MF A03 CSCL 07/6

The cyclic voltammetry and the potential dependence of conductivity for polyacetylene films on platinum electrode arrays have been studied in both liquid SO2 electrolyte and tetrahydrofuran electrolyte. The polyacetylene was prepared by thermolysis of films of poly (7,8-bistrifluoromethyl-tricyclo 4.2.2.0 2,5 deca-3,7,9-triene) deposited on interdigitated electrode arrays. When oxidized in liquid SO2 electrolyte, polyacetylene has a maximum in conductivity a polyvinylferrocene internal reference, and conductivity is three orders of magnitude lower at +2.0 V. The width of the window of high conductivity is the largest yet observed for a conducting polymer. GRA

N91-24443# Akron Univ., OH. Inst. of Polymer Science.
FRACTURE MECHANICS AND CAVITATION IN RUBBERLIKE SOLIDS
A. N. Gent and C. Wang Mar. 1991 26 p
(Contract N00014-85-K-0222)
(AD-A233310; TR-26) Avail: NTIS HC/MF A03 CSCL 11/10

Conditions for propagation of a pressurized crack within a rubberlike solid are derived in terms of the elastic properties of rubber, the energy G sub c and the initial radius r sub o of the crack. A previously-proposed criterion, that the critical internal pressure P sub c for crack growth is given by 5E/6, where E is the tensile (Young) modulus of elasticity, is shown to be inadequate both for small cracks, when the stiffening of rubber at high strains must be taken into account, and for large cracks, when the critical degree of inflation is so small that the assumptions leading to P sub c = 5E/6 do not apply. However, this simple criterion is found to remain a useful guide for cracks having initial radii lying in an intermediate range, such that r sub o (E/G sub c) lies between about 0.0005 and 1. For representative rubberlike solids, this corresponds to the range r sub o = 0.5 microns to 1 mm. GRA

N91-24444# Arizona Univ., Tucson. Optical Sciences Center.
NONLINEAR ORGANICS FOR GUIDED-WAVE DEVICES Final Report, 1 Sep. 1988 - 31 Aug. 1990
G. I. Stegeman 29 Nov. 1990 22 p
(Grant AF-AFOSR-0317-88; AF Proj. 2305)
(AD-A233404; AFOSR-91-0200TR) Avail: NTIS HC/MF A03 CSCL 07/3

This final report presents research into the use of nonlinear organic materials for guided-wave devices. Discussed are progress in the development of new measurement techniques; poly-4BCMU films and waveguides; and other polymer materials. GRA

N91-24445# Akron Univ., OH. Inst. of Polymer Engineering.
EFFECT OF TEMPERATURE AND OXYGEN ON THE STRENGTH OF ELASTOMERS
A. N. Gent, Ginger L. Liu, and T. Sueyasu Mar. 1991 42 p
(Contract N00014-85-K-0222)
(AD-A233535; TR-27) Avail: NTIS HC/MF A03 CSCL 20/11

Measurements have been made of the tear energy G of SBR and BR vulcanizates as a function of rate of tearing, temperature, and air pressure. Approximately linear relations were obtained between the logarithm of the rate of tearing at a fixed energy input and the reciprocal of absolute temperature, over the range 25 to 130 C. Apparent activation energies of 20 to 32 kcal/mole were deduced for the tear strength, much larger than predicted by the WLF relation for changes in viscous losses with temperature far above Tg. GRA

N91-24446# Ultrasystems Defense and Space Systems, Inc., Irvine, CA.
BORON NITRIDE AND ITS PRECURSORS Final Report, 1 Jul. 1985 - 31 Mar. 1990
K. L. Paciorek 14 Feb. 1991 6 p
(Contract N00014-87-C-0713)
(AD-A233538) Avail: NTIS HC/MF A02 CSCL 07/6

The objective was to develop processible preceramic polymers amenable to transformation into pure boron nitride for applications as fibers and coatings. Pyrolysis of B-tri (amino)-N-tris (trimethylsily) - borazine gave a fusible BN precursor amenable to continuous filament fiber drawing. These were transformed into BN ceramic fibers. From B, B', B'' - trichloroborazine and hexamethyldisilazane was obtained a soluble/nonfusible BN precursor utilized for coatings applications on carbon and alumina fibers. Linear 2-, 3-, and 4-BN systems were synthesized and evaluated. Functional linear BN compounds were prepared. Reactions of the materials synthesized were studied and operative mechanisms postulated.
GRA

N91-24447# Argonne National Lab., IL.
IMPLEMENTATION AND VERIFICATION OF A VISCOPLASTIC MATERIAL MODEL USING THE ANSYS CODE
Z. Wang, P. Turula, and G. F. Popper 1991 6 p Presented at the 5th ANSYS International Conference and Exhibition, Pittsburgh, 20-24 May 1991
(Contract W-31-109-eng-38)
(DE91-010571; ANL/CP-72527; CONF-9105159-1) Avail: NTIS HC/MF A02

Numerical results from the viscoplastic material model were compared to theoretical and numerical results. This viscoplastic model worked well for the cases investigated and can be expected to give reasonable results for viscoplastic structural analysis.
DOE

N91-24448# International Centre for Theoretical Physics, Trieste (Italy).
STRUCTURE BREAKING AND ELECTRON LOCALIZATION IN LIQUID CRYOLITE-SODIUM SOLUTIONS
Z. Akdeniz and M. P. Tosi Sep. 1990 23 p
(DE91-618515; IC-90/279) Avail: NTIS HC/MF A03

The continuous nonmetal-metal transition, which occurs on dissolving metals in molten salts, may be shifted to higher metal concentration in solutions involving polyvalent metal ions by the possibility that these metals go into lower oxidation states. We evaluate a microscopic model for these processes in the specific case of solutions of sodium metal in molten cryolite (AlF3-3NaF). The structure of the ionic melt is understood and calculable at the microscopic level in terms of a dominant sixfold-coordinated trivalent state of the Al ion (the AlF6(3-) complex) with some admixture of a fourfold-coordinated trivalent state (the AlF4(1-) complex). The sodium metal is assumed to enter the ionic liquid in the form of monovalent ions and electrons. Our calculations demonstrate how these added components break up the structure of the ionic melt to yield localization by the formation of Al ions in reduced valence states, and provide order-of-magnitude estimates for the free energy changes involved in these processes. Specifically, we find that with increasing metal concentration, the equilibrium between AlF6(3-) and AlF4(1-) shifts in favor of the latter, while Al(3+) ions are released in the melt and bind the available electrons to form Al(2+) and Al(1+) ions. The latter eventually become the most stable ones and also destabilize the AlF4(1-) complex. This scenario is consistent with available macroscopic observations. We also briefly discuss how the treatment could be extended to examine other events that may arise with increasing metal content, such as the formation of dimers or small metal clusters.
DOE

N91-24449# Melbourne Univ., Parkville (Australia). School of Physics.
FERROELECTRIC AND FERROELASTIC DOMAIN STRUCTURES IN PIEZOELECTRIC CERAMICS
L. A. Bursill and Peng JuLin 1990 10 p
(DE91-618676; UM-P-90/64) Avail: NTIS HC/MF A02

A discussion of the results of conventional and high-resolution high-voltage electron microscopic studies of two ferroelectrics, barium sodium niobate, and lead zirconium titanate is presented. It is shown that a rich variety of information such as ferroelectric and/or ferroelastic domains discommensurations versus antiphase boundaries, extended versus localized chemical defects, and multiphase versus grain boundaries, become accessible in both single crystal and polycrystalline piezoelectrics, when a combination of high-resolution and conventional electron optical techniques are used.
DOE

N91-24450# Sandia National Labs., Albuquerque, NM.
CONTRIBUTIONS OF POLYMERS TO BENTONITE AND SAPONITE FLUIDS
N. Guven, L. L. Carney, and D. J. Panfil Feb. 1991 53 p
Prepared in cooperation with Texas Tech Univ., Lubbock, TX
(Contract DE-AC04-76DP-00789)
(DE91-009855; SAND-88-7113) Avail: NTIS HC/MF A04

Polymers have been used in drilling fluids for many years. However, the confusion surrounding the use of polymers in the oil field has severely limited their effectiveness. Many oilfield workers simply put all polymers in the same category without regard to the many differences that exist among them. Homopolymers and copolymers of acrylic acid and a copolymer of styrene and maleic anhydride are found to have profound effects on the rheological and filtration properties of clay-based fluids up to 300 F. These contributions of the polymers are greatly diminished when the clay/polymer fluids were autoclaved at 400 F. Thus, the effects of these polymers are expected to be negligible at and above 400 F. Homo- and co-polymers of acrylic acid with molecular weights below 5000 almost eliminate the anomalous viscosity rise of the bentonite fluids at temperatures between 250 to 450 F. A homopolymer of acrylic acid with a molecular weight of 60,000 and a co-polymer of styrene and maleic anhydride with very high molecular weight further enhances the anomalous viscosity rise of the bentonite fluid. The original viscosity profile of the saponite fluid is characterized with a high initial viscosity up to 200 F which is followed by a steep thinning at higher temperatures. The addition of homo- and co-polymer of acrylic acid causes a complete reversal in the fluid viscosity. They become thin at lower temperatures (up to 250 F) and experience a sudden viscosity rise at higher temperatures. All the above polymers greatly improve the filtration losses of the fluids at room temperatures as indicated by the API test. The filtration tests at high pressure and high temperatures were inconclusive due to the frequent blow-outs that occur during the tests.
DOE

N91-24451*# Ford Motor Co., Dearborn, MI.
IMPROVED SILICON CARBIDE FOR ADVANCED HEAT ENGINES Final Technical Report
Thomas J. Whalen May 1989 60 p
(Contract NAS3-24384)
(NASA-CR-182289; NAS 1.26:182289) Avail: NTIS HC/MF A04 CSCL 11C

The development of high strength, high reliability silicon carbide parts with complex shapes suitable for use in advanced heat engines is studied. Injection molding was the forming method selected for the program because it is capable of forming complex parts adaptable for mass production on an economically sound basis. The goals were to reach a Weibull characteristic strength of 550 MPa (80 ksi) and a Weibull modulus of 16 for bars tested in four-point loading. Statistically designed experiments were performed throughout the program and a fluid mixing process employing an attritor mixer was developed. Compositional improvements in the amounts and sources of boron and carbon used and a pressureless sintering cycle were developed which provided samples of about 99 percent of theoretical density. Strengths were found to improve significantly by annealing in air. Strengths in excess of 550 MPa (80 ksi) with Weibull modulus of about 9 were obtained. Further improvements in Weibull modulus to about 16 were realized by proof testing. This is an increase of

86 percent in strength and 100 percent in Weibull modulus over the baseline data generated at the beginning of the program. Molding yields were improved and flaw distributions were observed to follow a Poisson process. Magic angle spinning nuclear magnetic resonance spectra were found to be useful in characterizing the SiC powder and the sintered samples. Turbocharger rotors were molded and examined as an indication of the moldability of the mixes which were developed in this program. Author

N91-24452*# Woven Structures, Inc., Compton, CA.
TAILORABLE ADVANCED BLANKET INSULATION USING ALUMINOBOROSILICATE AND ALUMINA BATTING
Dominic P. Calamito Jul. 1989 93 p
(Contract NAS2-12693)
(NASA-CR-177527; NAS 1.26:177527) Avail: NTIS HC/MF A05 CSCL 11C

Two types of Tailorable Advanced Blanket Insulation (TABI) flat panels for Advanced Space Transportation Systems were produced. Both types consisted of integrally woven, 3-D fluted core having parallel faces and connecting ribs of Nicalon yarns. The triangular cross section flutes of one type was filled with mandrels of processed Ultrafiber (aluminoborosilicate) stitchbonded Nextel 440 fibrous felt, and the second type wall filled with Saffil alumina fibrous felt insulation. Weaving problems were minimal. Insertion of the fragile insulation mandrels into the fabric flutes was improved by using a special insertion tool. An attempt was made to weave fluted core fabrics from Nextel 440 yarns but was unsuccessful because of the yarn's fragility. A small sample was eventually produced by an unorthodox weaving process and then filled with Saffil insulation. The procedures for setting up and weaving the fabrics and preparing and inserting insulation mandrels are discussed. Characterizations of the panels produced are also presented. Author

N91-24380*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
PROCESSING OF GLASS-CERAMICS FROM LUNAR RESOURCES
B. D. Fabes and W. H. Poisl *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 11C

N91-24382*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
HIGH TEMPERATURE SEALS BETWEEN CERAMIC SEPARATION MEMBRANES AND SUPER-ALLOY HOUSING
G. Honea and K. R. Sridhar *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 5 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 11C

N91-25018*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PRELIMINARY FINDINGS OF THE LDEF MATERIALS SPECIAL INVESTIGATION GROUP Abstract Only
Bland A. Stein and H. Gary Pippin (Boeing Aerospace Co., Seattle, WA.) *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 51 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25019*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CHEMICAL CHARACTERIZATION OF SELECTED LDEF POLYMERIC MATERIALS Abstract Only
Philip R. Young and Wayne S. Slemp *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 52 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25020*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
PRELIMINARY INVESTIGATION OF THIN FILM POLYMERS EXPOSED TO LOW EARTH ORBIT Abstract Only
Thomas Strganac, Allan Farrow, and Alan Letton *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 53 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25021*# Texas A&M Univ., College Station. Polymer Science and Engineering Program.
STUDY OF BALLOON AND THERMAL CONTROL MATERIAL DEGRADATION ABOARD LDEF Abstract Only
Alan Letton, Neil I. Rock, Kevin D. Williams, and Thomas Strganac *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 54 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25022*# Texas A&M Univ., College Station. Polymer Science and Engineering Program.
THE INFLUENCE OF FLOWING AFTERGLOW EXPOSURE ON THE DEGRADATION OF VARIOUS POLYMERIC MATERIALS Abstract Only
Alan Letton, Neil I. Rock, and Kevin D. Williams *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 55 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25023*# Alabama Univ., Huntsville.
CHEMICAL ANALYSIS OF METAL AND POLYMER SURFACES ON THE FRONT AND REAR LDEF Abstract Only
L. Christi, John C. Gregory, G. N. Raikar, J. J. Weimer, and R. Wiser *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 56 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25026*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ATOMIC OXYGEN STIMULATED OUTGASSING Abstract Only
Roger C. Linton and John M. Reynolds *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 59 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25028*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
PRELIMINARY RESULTS FOR LDEF/HEPP THERMAL CONTROL SAMPLES Abstract Only
Lon Kauder *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 61 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25029*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ATOMIC OXYGEN INTERACTIONS WITH FEP TEFLON AND SILICONES ON LDEF Abstract Only
Bruce A. Banks and Linda Gebauer (Cleveland State Univ., OH.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 62 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25030*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
VUV-INDUCED DEGRADATION OF FEP TEFLON ABOARD LDEF Abstract Only
David E. Brinza, Ranty H. Liang, and Albert E. Stiegman *In* NASA, Langley Research Center, First LDEF Post-Retrieval

Symposium Abstracts Jun. 1991 p 63 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25031*# Aerospace Corp., El Segundo, CA.
SPACE ENVIRONMENTAL EFFECTS ON SILVERED TEFLON THERMAL CONTROL SURFACES Abstract only
C. S. Hemminger, W. K. Stuckey, and J. C. Uht *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 64 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25032*# Boeing Aerospace and Electronics Co., Seattle, WA.
RESULTS OF EXAMINATION OF SILVERED TEFLON FROM THE LONG DURATION EXPOSURE FACILITY Abstract Only
Ken W. Rousslang, E. Russ Crutcher, and H. Gary Pippin *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 65 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25033*# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
PRELIMINARY INVESTIGATIONS INTO UHCRE THERMAL CONTROL MATERIALS Abstract Only
Francois Levadou, Mike Froggatt, Martin Rott, and Eberhard Schneider (Fraunhofer Inst. fuer Kurzzeitdynamik, Freiburg im Breisgau, Germany, F.R.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 66 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25034*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF LDEF FLIGHT EXPOSURE ON SELECTED POLYMERIC FILMS AND THERMAL CONTROL COATINGS Abstract Only
Wayne S. Slemp, Philip R. Young, and James Y. Shen (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 67 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25035*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THERMAL CONTROL SURFACES EXPERIMENT (S0069) INITIAL MATERIALS EVALUATION Abstract Only
Donald R. Wilkes, Leigh L. Hummer, M. John Brown (AZ Technology, Huntsville, AL.), and James M. Zwiener *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 68 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25036*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
UNUSUAL MATERIALS EFFECTS OBSERVED ON THE THERMAL CONTROL SURFACES EXPERIMENT (S0069) Abstract Only
James M. Zwiener, Donald R. Wilkes, and Leigh L. Hummer (AZ Technology, Huntsville, AL.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 69 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25037*# Centre d'Etudes et de Recherches, Toulouse (France).
SPACECRAFT THERMAL CONTROL COATINGS (AO 138-6) Abstract Only
Alain Paillous and Jean Claude Guillaumon (Centre National d'Etudes Spatiales, Toulouse, France) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 70 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25038*# Dayton Univ., OH.
THERMAL CONTROL MATERIALS Abstract Only
C. Hurley *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 71 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25039*# Boeing Aerospace and Electronics Co., Seattle, WA.
RESULTS OF EXAMINATION OF THE A-276 WHITE AND Z-306 BLACK THERMAL CONTROL PAINT DISCS FLOWN ON LDEF Abstract Only
Johnny L. Golden *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 72 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25040*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ION BEAM TEXTURED AND COATED SURFACES EXPERIMENT (IBEX) Abstract Only
Michael J. Mirtich, Nicholas Stevens, and James Merrow (Cleveland State Univ., OH.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 73 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25043*# Air Force Geophysics Lab., Hanscom AFB, MA. Space Physics Div.
PATTERNS OF DISCOLORATION AND OXIDATION BY DIRECT AND SCATTERED FLUXES, ESPECIALLY OXYGEN ON SILICON Abstract Only
A. R. Frederickson, R. C. Filz, F. J. Rich, and Paul L. Sagalyn (Army Materials Technology Lab., Watertown, MA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 76 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25044*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
THERMAL-VACUUM EFFECTS ON POLYMER MATRIX COMPOSITE MATERIALS Abstract Only
R. C. Tennyson and G. E. Mabson *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 77 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25045*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
ATOMIC OXYGEN EROSION OF POLYMER MATRIX COMPOSITES Abstract Only
R. C. Tennyson, J. Kleiman, and W. D. Morison *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 78 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25046*# Aerospace Corp., El Segundo, CA.
LONG DURATION EXPOSURE FACILITY EXPERIMENT M0003 DEINTEGRATION/FINDINGS AND IMPACTS Abstract Only
M. J. Meshishnek, S. R. Gyetvay, and C. H. Jaggers *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 79 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25047*# Aerospace Corp., El Segundo, CA.
LONG DURATION EXPOSURE FACILITY EXPERIMENT M0003 DEINTEGRATION OBSERVATIONS Abstract Only
S. R. Gyetvay, Laana Fishman, and M. J. Meshishnek *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 80 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25048*# Boeing Aerospace and Electronics Co., Seattle, WA.
SURVEY OF RESULTS FROM THE BOEING MODULES ON THE M0003 EXPERIMENT ON LDEF Abstract Only
H. Gary Pippin, Owen Mulkey, Juris Verzemnieks, Emmett Miller, Sylvester G. Hill, and Harry Dursch *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 81 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25057*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
EFFECTS OF SOLAR RADIATION ON GLASS Abstract Only
Dennis S. Tucker and Donald L. Kinser (Vanderbilt Univ., Nashville, TN.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 90 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25068*# McDonnell-Douglas Electronics Co., Saint Louis, MO.
POST-FLIGHT CHARACTERIZATION OF OPTICAL SYSTEM SAMPLES, THERMAL CONTROL SAMPLES, AND DETECTORS FROM LDEF EXPERIMENT M0003, SUB-EXPERIMENTS 6 AND 13 Abstract Only
Randall R. Hodgson, James N. Holsen, and Robert A. Drerup, Jr. (Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 102 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25070*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF LONG-DURATION EXPOSURE ON OPTICAL SYSTEM COMPONENTS Abstract Only
Gale A. Harvey *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 104 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25071*# Eastman Kodak Co., Rochester, NY.
EFFECTS OF LONG TERM EXPOSURE ON OPTICAL SUBSTRATES AND COATINGS (SOO50-1) Abstract Only
John Vallimont and Keith Havey *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 105 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25073*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECT OF SPACE EXPOSURE ON PYROELECTRIC INFRARED DETECTORS Abstract Only
James B. Robertson and Ivan O. Clark *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 107 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25074*# MATRA Service Aerodynamique, Velizy-Villacoublay (France).
VACUUM DEPOSITED OPTICAL COATINGS EXPERIMENT (AO 138-4) Abstract Only
Jean Charlier *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 108 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25076*# Reading Univ. (England). Infrared Multilayer Lab.
EXPOSURE TO SPACE RADIATION OF HIGH-PERFORMANCE INFRARED MULTILAYER FILTERS Abstract Only
J. S. Seeley, G. J. Hawkins, and R. Hunneman *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 110 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25078*# Barr Associates, Inc., Westford, MA.
TRANSMITTANCE MEASUREMENTS OF ULTRA VIOLET AND VISIBLE WAVELENGTH INTERFERENCE FILTERS FLOWN ABOARD LDEF Abstract Only
Thomas A. Mooney and Ali Smajkiewicz *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 112 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

N91-25082*# Martin Marietta Labs., Baltimore, MD.
STUDY OF FACTORS DETERMINING THE RADIATION SENSITIVITY OF QUARTZ CRYSTAL OSCILLATORS (AO189) Abstract Only
J. S. Ahearn and J. D. Venables *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 116 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

N91-24453# Sandia National Labs., Albuquerque, NM.
ADVANCED THERMALLY STABLE JET FUELS DEVELOPMENT PROGRAM ANNUAL REPORT. VOLUME 3: FUEL LUBRICITY Interim Technical Report, Jun. 1989 - Oct. 1990
John P. Cuellar, Jr. 15 Jan. 1991 28 p
(Contracts DE-AC04-76DP-00789; FY1455-89-N-0635)
(AD-A232793; WRDC-TR-90-2079-Vol-3) Avail: NTIS HC/MF A03 CSCL 21/4

A program to evaluate the effects of additives on JP-8 fuel lubricity at high temperatures is described. Operating temperatures up to 163 C were examined, with a subsequent program goal of 315 C. Baseline data were obtained using the Ball-on-Cylinder Lubricity Evaluator (BOCLE). High-temperature data were obtained with an apparatus known as the Cameron-Plint High Frequency Reciprocating Machine. The most significant effect of variables observed was a consequence of a change in wear specimen material from 52100 steel to M-50 steel--the latter considered to be representative of advanced fuel system designs. Use of M-50 wear coupons resulted in considerably reduced wear levels with only slight separation between neat or additized fuels. M-50 specimen roughness was a major influence in wear level. At finalized test conditions, a dibasic acid ester, di(2-ethylhexyl) adipate, was found to give the lowest wear values when used as an additive in clay-treated JP-8, although distinctions between the various additized fuels were not large. GRA

N91-24454 Department of the Navy, Washington, DC.
PROPELLANT GRAIN DESIGN Patent
James W. Andrew, inventor (to Navy) 26 Jun. 1990 8 p Filed 28 Nov. 1988
(AD-D014829; US-Patent-4,936,092; US-Patent-Appl-SN-276992; US-Patent-Class-60-245) Avail: US Patent and Trademark Office CSCL 21/9

This patent discloses a solid propellant rocket motor propellant grain configuration having a center bore of a varying diameter, ballistic slots, a stress/ballistic groove, and a burn inhibitor band for withstanding service motor operating environments and providing the required ballistic profile. GRA

N91-24455 Department of the Navy, Washington, DC.
ENERGETIC BINDERS FOR PLASTIC BONDED EXPLOSIVES Patent
Horst G. Adolph, inventor (to Navy), Judah Goldwasser, inventor (to Navy), and G. W. Lawrence, inventor (to Navy) 29 Jan. 1991 5 p Filed 30 Apr. 1986
(AD-D014830; US-Patent-4,988,397; US-Patent-Appl-SN-892622; US-Patent-Class-149-19.3) Avail: US Patent and Trademark Office CSCL 19/1

This patent discloses an energetic uncured binder composite mixture comprising: (1) a hydroxy-terminated polyfluoroformal prepolymer of the general formula HOCH2 (CF2)-nCH2-(OCH2OCH2(CF2) nCH2-)mOH wherein n is 3 or 4 and m is selected to provide a number average molecular weight of from about 1,000 to about 10,000 for the prepolymer; and (2) an energetic plasticizer which is bis (2,2-dinitropropyl) formal, bis (2,2-trinitroethyl) formal, bis (2-fluoro 2,2-dinitroethyl) formal, bis (2,2-difluoro 2-nitroethyl) formal, 2,2-dinitropropyl 2-fluoro 2,2-dinitroethyl formal, or mixtures thereof; wherein the weight ratio of energetic plasticizer to prepolymer is from about 2:1 to about 5:1. This binder composite mixture is useful for preparing energetic plastic bonded explosives having high chemical and thermal stabilities. GRA

N91-24456# FTR, Inc., Red Bank, NJ.
A HIGH-SPEED MULTISPECTRA INFRARED DIGITAL VIDEO SYSTEM TO MEASURE THE REACTION FRONTS OF SOLID PROPELLANTS Report, 1 Jun. - 31 Dec. 1990
Harout Jamgotchian and K. T. Rhee 15 Jan. 1991 38 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Contract DAAL03-90-C-0015)
(AD-A233276; ARO-27933.1-EG-SBI) Avail: NTIS HC/MF A03 CSCL 17/5

The work was to design a new multispectra infrared (MS-IR) digital imaging system by employing multiple parallel processing focal plane detector arrays (FPDA) and spectrometry to measure the reaction front of impacted solid propellants. The new system is a high-speed spectral IR spectroscopic digital imaging system operated by a desk-top computer and the raw data will be processed by using our user-friendly software package. The new system with a magnification ratio of 11.271 will enable us to capture IR images of objects (with size as small as 2 to 4 micrometer) at variable framing rates, as high as 20 million frames/sec, up to four successive digital images; it will also allow us to determine the apparent distributions of temperature and water vapor through the line-of-path. The system will equipped with both calibration and synchronization devices so that the events taking place in a sample with about 1 sq mm size under sudden impact can quantitatively determined. The new system has an object mirror with f/1.0 having diameter of over 150 mm so that we can use the system on various apparatus including a drop-weight setup or a gas-gun facility. GRA

N91-24457# Cornell Univ., Ithaca, NY. School of Applied and Engineering Physics.
THE DETECTION OF THE FORMYL RADICAL FOR STUDIES OF THE FLAME ZONE CHEMISTRY OF SOLID PROPELLANTS Final Technical Report, 30 Sep. 1987 - 30 Sep. 1990
Terrill A. Cool 31 Jan. 1991 40 p
(Contract DAAL03-87-K-0066)
(AD-A233302; ARO-24115.5-CH) Avail: NTIS HC/MF A03 CSCL 21/9

Two laser-based diagnostic methods, resonance-enhanced multiphoton ionization (REMPI) and laser-induced fluorescence (LIF) were used for species concentration measurements in selected hydrocarbon flames. The results were compared with the predictions of present computer modeling codes as a demonstration of the state-of-the-art in flame species profile determinations. The quantitative detection of the formyl radical (HCO) was of primary interest in these studies because of its importance as a key reaction intermediate in the combination of solid propellants. The species monitored in these studies were O, H, OH, CH, HCO, and CH3. GRA

N91-24458# Southwest Research Inst., San Antonio, TX. Fuels and Lubricants Research Facility.
FIELD DEMONSTRATION OF AVIATION TURBINE FUEL MIL-T-83133C, GRADE JP-8 (NATO CODE F-34) AT FORT BLISS, TX Interim Report, 1 Feb. 1989 - 31 Jul. 1990
Walter E. Butler, Jr., Ruben A. Alvarez, Douglas M. Yost, Steven R. Westbrook, and Janet P. Buckingham Dec. 1990 124 p
(Contract DAAK70-87-C-0043; DA Proj. 1L2-63001-D-150)
(AD-A233441; BFLRF-264) Avail: NTIS HC/MF A06 CSCL 21/4

A JP-8 fuel demonstration was initiated at Ft. Bliss, TX, to demonstrate the impact of using aviation turbine fuel MIL-T-83133C, grade JP-8 in all military diesel fuel consuming ground vehicles and equipment. Three major organizations, one ordnance battalion and two activities with a total of 2807 vehicles/equipment (V/E), were identified as participants in the demonstration program, which is authorized to continue through 30 September 1991. No fuel storage tank or V/E fuel cells were drained and flushed prior to introduction of JP-8 fuel. This procedure resulted in a commingling of JP-8 fuel with existing diesel fuel. As of 31 July 1990 approximately 4,700,000 gallons of JP-8 fuel had been dispensed to user units at Ft. Bliss and at Ft. Irwin National Training Center (NTC) in California. Three areas of concern arose from the beginning of the program: (1) plugging of fuel filters, (2) loss of power, and (3) overheating. The use of JP-8 fuel did not cause or exacerbate any V/E fuel filter plugging. Where power loss was apparent, generally it was commensurate with the difference in heating values between JP-8 and diesel fuel. The V/E at Ft. Bliss operated satisfactorily with the JP-8 fuel with no alterations, mechanical or otherwise, having to be made to any engines or fuel systems. There were no major differences in fuel procurement costs, V/E fuel consumption, AOAP-directed oil changes, and fuel-wetted component replacements. GRA

N91-24459# Oak Ridge National Lab., TN.
THE FEDERAL METHANOL FLEET: A DEMONSTRATION OF METHANOL VEHICLE TECHNOLOGY
R. N. McGill and B. H. West 1991 7 p Presented at the 1991 Technical and Business Exhibition on Transportation, Huntsville, 14-15 May 1991
(Contract DE-AC05-84OR-21400)
(DE91-010395; CONF-9105161-1) Avail: NTIS HC/MF A02

The Federal Methanol Fleet, a Department of Energy (DOE) project initiated in 1985, is now in its final phases of operation, and much has been learned about the status of technology available for methanol fueled vehicles. Results are summarized from emissions tests, special lubricant tests, and drivers' impressions of the vehicles. Overall, the project was a success; drivers have accepted the methanol vehicles quite well; and data and results were transferred to those who can make best use of them. DOE

N91-24460*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A PRESSURE CONTROL ANALYSIS OF CRYOGENIC STORAGE SYSTEMS
C.-S. Lin (Analex Corp., Fairview Park, OH.), N. T. VanDresar, and M. M. Hasan 1991 10 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; cosponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104409; E-6235; NAS 1.15:104409; AIAA-91-2405) Avail: NTIS HC/MF A02 CSCL 21I

Self-pressurization of cryogenic storage tanks due to heat leak through the thermal protection system is examined along with the

performance of various pressure control technologies for application in microgravity environments. Methods of pressure control such as fluid mixing, passive thermodynamic venting, and active thermodynamic venting are analyzed using the homogeneous thermodynamic model. Simplified equations suggested may be used to characterize the performance of various pressure control systems and to design space experiments. Author

N91-24461# Virginia Polytechnic Inst. and State Univ., Blacksburg.
PREPARATION OF BILIQUID FOAM COMPOSITIONS
D. R. Jaasma, D. C. Osucha, and J. Scheuren 12 Dec. 1990 21 p
(Contract DE-FG01-87CE-15308)
(DE91-006740; DOE/CE-15308/T1) Avail: NTIS HC/MF A03

Technology developed by the late Dr. Felix Sebba of the VPI Chemical Engineering Department by which an oil phase can be broken up into small droplets and encapsulated in a continuous water phase led to research on the possible merits of a fuel prepared by this procedure. The resulting mixture is called a polyaphron. Part 1 of this report describes the testing of polyaphronated gasoline in an automobile engine. Nitrogen oxide emissions, total hydrocarbon emissions, and exhaust temperature were determined for various load and RPM combinations. Difficulties with viscosity and separation of the water phase have prevented complete testing at road load conditions. Rather than continue with engine testing, some bench tests of polyaphrons were performed to see the effect of various filtering processes on fuel stability as well as measuring viscosity and density. These results are reported in Part 2 of this paper. DOE

N91-24462# Argonne National Lab., IL.
THE 1990 SAE METHANOL CHALLENGE: SUMMARY OF A SUCCESSFUL STUDENT DESIGN COMPETITION
R. P. Larsen and N. W. Hill 1990 21 p Presented at the Society of Automotive Engineers (SAE) International Congress and Exhibition, Detroit, 26 Feb. - 2 Mar. 1990
(Contract W-31-109-eng-38)
(DE91-010276; ANL/CP-72154; CONF-9002115-2) Avail: NTIS HC/MF A03

A follow-up to the 1989 Society of Automotive Engineers (SAE) Methanol Marathon called the Methanol Challenge was held in April 1990. One of a series of engineering student competitions using alternative fuels organized and conducted by the Center for Transportation Research at Argonne National Laboratory, the Methanol Challenge pushed the technology for dedicated M85 (85 percent methanol, 15 percent hydrocarbon fuel) methanol passenger cars to new levels. The event included complete Federal exhaust emissions, cold-start and driveability, performance, and fuel economy testing. Twelve teams of student engineers from the United States and Canada competed in the Challenge using Chevrolet Corsicas donated by General Motors (GM) to the schools. The winning car, from the University of Tennessee, simultaneously demonstrated extremely low emissions, dramatically increased performance, and significantly improved fuel economy. This paper describes the goals, the conversion approaches used by the various university students, and results of the competition on emissions, cold-start, road rally performance, fuel economy, cold driveability, acceleration, maneuverability, and exhaust noise. DOE

N91-24261*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Propulsion and Chemical Systems Section.
LONG-TERM PROPELLANT/MATERIAL COMPATIBILITY
Clifford M. Moran *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 299-306 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20 CSCL 22I

N91-24263*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE COLD-SAT EXPERIMENT FOR CRYOGENIC FLUID MANAGEMENT TECHNOLOGY
J. R. Schuster, J. P. Wachter (Ford Aerospace and Communications Corp., Palo Alto, CA.), and D. M. Vento *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 317-331 (For primary document see N91-24233 16-20)
(Contract NAS3-25062)
Avail: NTIS HC/MF A20 CSCL 21I

N91-24285# Hercules, Inc., Radford, VA. Aerospace and Ordnance Group.
PROCESS AND QUALITY IMPROVEMENTS FOR M7 PROPELLANT
R. A. Gott *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 171-180 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

N91-24296# Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ.
MOLECULAR STRUCTURE OF LOW TEMPERATURE FORM OF TRIAMINOGUANIDINIUM NITRATE (TAGN)
A. J. Bracuti *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 331-344 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

N91-24297# Naval Ordnance Station, Indian Head, MD.
HEATS OF EXPLOSION, DETONATION AND REACTION PRODUCTS: THEIR ESTIMATION AND RELATION TO THE FIRST LAW OF THERMODYNAMICS
Edward E. Baroody and Susan T. Peters *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 345-354 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

N91-24298# Sandia National Labs., Albuquerque, NM.
LIQUID PROPELLANT INJECTOR/COMBUSTOR TESTS Progress Report
R. E. Rychnovsky, R. W. Carling, and S. K. Griffiths *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 363-367 Sponsored in part by DOD (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

N91-25058*# Thiokol Corp., Brigham City, UT.
SPACE AGING OF SOLID ROCKET MATERIALS Abstract Only
Dean M. Lester, Leon L. Jones, R. B. Smalley, Jr., and R. Neil Ord *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 92 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 21I

29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology.*

N91-24463*# Center for Space and Advanced Technology, Fairfax, VA.
MICROGRAVITY STRATEGIC PLANNING EXERCISE Final Report
Richard Halpern, Jim Downey, and Harold Harvey 15 Apr. 1991 109 p
(Contract NAS8-38669)
(NASA-CR-188021; NAS 1.26:188021) Avail: NTIS HC/MF A06 CSCL 22A

The Center for Space and Advanced Technology supported a planning exercise for the Microgravity Program management at the Marshall Space Flight Center. The effort focused on the status of microgravity work at MSFC and elsewhere with the objective of preparing a goal-oriented strategic planning document which could be used for informational/brochure purposes. The effort entailed

numerous interactions and presentations with Field Center programmatic components and Headquarters personnel. Appropriate material was consolidated in a draft format for a MSFC Strategic Plan. Author

N91-24464*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MICROGRAVITY RESEARCH AT LeRC
Fred J. Kohl 1990 7 p Presented at the CSME Mechanical Engineering Forum 1990, Toronto, Ontario, 3-9 Jun. 1990; sponsored by the Canadian Society for Mechanical Engineering
(NASA-TM-102521; E-5325; NAS 1.15:102521) Avail: NTIS HC/MF A02 CSCL 22A

The NASA Lewis Research Center is conducting a wide variety of ground-based science and microgravity flight experiments in the disciplines of fluid physics and transport phenomena, combustion science, and materials science. Extensive use is made of low-gravity ground-based facilities such as drop towers and a Learjet aircraft, as well as extensive normal-gravity laboratories. The ground-based facilities are utilized to execute science programs, perform precursor tests to define space experiment science requirements and conceptual designs, and also to perform tests for space experiment technology development and verification. Finally, flight hardware is designed, developed and flown on the Space Shuttle. Author

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

N91-24465# National Inst. of Standards and Technology, Boulder, CO. Chemical Engineering Science Div.
EFFECT OF NOBLE GAS MIXTURES ON THE PERFORMANCE OF REGENERATIVE-TYPE CRYOCOOLERS ANALYTICAL ESTIMATE
D. E. Daney Sep. 1990 38 p Sponsored by AF
(PB91-144410; NISTIR-90/3936) Avail: NTIS HC/MF A03 CSCL 13B

The performance of regenerators that use noble gas mixtures is compared to the performance of those that use pure helium gas. Both helium-argon and helium-krypton mixtures are investigated. For some heat transfer surfaces, a modest gain in heat transfer can be achieved with these mixtures. The concomitant increase in pressure drop, however, more than offsets the heat transfer gain so the net regenerator loss increases for all evaluated cases. The dependence of heat transfer on Prandtl number (Pr) was not measured for the range associated with noble gas mixtures, 0.2 less than Pr less than 0.5, and it is estimated that the uncertainty from the source can exceed 20 percent. The estimates for the transport properties (Prandtl number, viscosity, and thermal conductivity) of helium-argon and helium-krypton mixtures because of the absence of experimental data at low temperature are given. GRA

N91-24466# Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
LOAD TRANSFER MECHANISMS IN ANCHORED GEOSYNTHETIC SYSTEMS Final Report, 15 Mar. 1988 - 14 Sep. 1990
Roman D. Hryciw 20 Dec. 1990 218 p
(Grant AF-AFOSR-0166-88; AF Proj. 2302)
(AD-A232798; AFOSR-91-0137TR) Avail: NTIS HC/MF A10 CSCL 08/10

Success of an anchored geosynthetic system (AGS) depends on the satisfactory transfer of load between: the surface-deployed geosynthetic and anchors (typically ribbed reinforcing rods) driven into the slope; the geosynthetic and soil; and the anchors and soil. A study was performed to evaluate the load transfer mechanisms at these interfaces in an AGS. A mathematical model was developed for predicting the pullout resistance of plane ribbed inclusions. The model considered the contribution of both frictional and passive resistance components of pullout resistance. Optical observation of sand around the ribs was made to determine the behavior of soil around the moving ribs during pullout. A theoretical study disclosed that the optimum anchor orientation for stabilization of infinite slopes depends on several factors including slope angle and in-situ stresses. It typically ranges from 20 to 30 degree from the normal to the slope with the anchor driven upslope. An experimental study confirmed that the soil-geosynthetic interface friction angle may be correctly predicted from the residual or critical state friction angle of the sand. Equations were developed for load transfer at curved soil-fabric interfaces. An experimental study verified that the increases in soil stress with distance from the anchor may be predicted by the developed equations. GRA

N91-24467# Rice Univ., Houston, TX. Dept. of Mathematical Sciences.
PARALLEL OPTIMIZATION AND INVERSE PROBLEMS Annual Report, 15 May 1989 - 30 Sep. 1990
John E. Dennis, Jr., Steven Cox, Richard A. Tapia, Virginia Torczon, and R. M. Lewis Jun. 1990 7 p
(Grant AF-AFOSR-0363-89; AF Proj. 2304)
(AD-A233371; AFOSR-91-0208TR) Avail: NTIS HC/MF A02 CSCL 20/1

The principle work of one of us (WWS) over the last several years has concerned the determination of wave velocities from reflected wave measurements. The analysis indicated a way to modify least squares inversion to enable the effective determination of velocities. This modification, dubbed the coherency method, was analyzed. The coherency method is really a class of algorithms. One such algorithm was implemented numerically, and tested it on both synthetic and field seismic data. This version is limited to the explanation of horizontally stratified models from plane wave data sets. This set up can be analyzed rather completely, and is still of sufficient complexity to be more applicable to some field data sets (though not to others). More recently, the method was redesigned to apply to multidimensional models and to point source data. At present, the coherency method is the only class of algorithms with demonstrated ability to extract accurate velocity estimates directly from field seismic data. GRA

N91-24468# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Technology Div.
BRIEF INTRODUCTION TO NONCONTACT TYPE LARGE-DIMENSION THREE-COORDINATE MEASUREMENT SYSTEM
Hu Yuan, Yu Chengbin, and Ma Xiaosu 23 Oct. 1990 8 p Transl. into ENGLISH from Jiliang Jishu (China), no. 5, 1989 p 3-4
(AD-A233436; FTD-ID(RS)T-0549-90) Avail: NTIS HC/MF A02 CSCL 14/2

A noncontract type large dimension three coordinate measurement system (LDMS) is presented which was developed by the authors, thus realizing spatial three coordinate measurements with ranges between several to tens of meters. The main indicators of measurements, such as precision and system function, have reached the advanced level of the same kind of system made abroad for extensive applications in aeronautics, aerospace, shipbuilding, power and architecture. The fundamental layout of the LDMS system includes two sets of model T2000S electronic transits, one set of IBM-PC microcomputer system, one set of data collecting device, as well as one set of measurement accessories. GRA

N91-24469*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ALPHA-CANONICAL FORM REPRESENTATION OF THE OPEN LOOP DYNAMICS OF THE SPACE SHUTTLE MAIN ENGINE
Almet Duyar, Vasfi Eldem (Florida Atlantic Univ., Boca Raton.), Walter C. Merrill, and Ten-Huei Guo 1991 22 p Presented at the American Control Conference, Boston, MA, 26-28 Jun. 1991; sponsored by the American Automatic Control Council
(NASA-TM-104422; E-6255; NAS 1.15:104422) Avail: NTIS HC/MF A03 CSCL 13B

A parameter and structure estimation technique for multivariable systems is used to obtain a state space representation of open loop dynamics of the space shuttle main engine in alpha-canonical form. The parameterization being used is both minimal and unique. The simplified linear model may be used for fault detection studies and control system design and development. Author

N91-24470*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LN2 SPRAY DROPLET SIZE MEASUREMENT VIA ENSEMBLE DIFFRACTION TECHNIQUE
N. H. Saiyed, J. Jurns (Sverdrup Technology, Inc., Brook Park, OH.), and David J. Chato 1991 14 p Presented at the 26th Thermophysics Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(NASA-TM-104443; E-6283; NAS 1.15:104443; AIAA-91-1381)
Avail: NTIS HC/MF A03 CSCL 13B

The size of subcooled liquified nitrogen droplets are measured with a 5 mW He-Ne laser as a function of pressure difference (delta P) across flat spray and full cone pressure atomizing nozzles. For delta P's of 3 to 30 psid, the spray sauter mean diameter (SMD) ranged between 250 to 50 microns. The pressure range tested is representative of those expected during cryogenic fluid transfer operations in space. The droplet sizes from the flat spray nozzles were greater than those from the full cone nozzle. A power function of the form, SMD varies as delta P(exp a), describes the spray SMD as a function of the delta P very well. The values of a were -0.36 for the flat spray and -0.87 for the full cone. The reduced dependence of the flat spray SMD on the delta P was probably because of: (1) the absence of a swirler that generates turbulence within the nozzle to enhance atomization, and (2) a possible increase in shearing stress resulting from the delayed atomization due to the absence of turbulence. The nitrogen quality, up to 1.5 percent is based on isenthalpic expansion, did not have a distinct and measurable effect on the spray SMD. Both bimodal and monomodal droplet size population distributions were measured. In the bimodal distribution, the frequency of the first mode was much greater than the frequency of the second mode. Also, the frequency of the second mode was low enough such that a monomodal approximation probably would give reasonable results. Author

N91-24471*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
ADVANCED LAUNCH SYSTEM PROPULSION FOCUSED TECHNOLOGY LIQUID METHANE TURBOPUMP TECHNICAL IMPLEMENTATION PLAN
A. Csomor and C. E. Nielson 25 May 1989 50 p
(Contract NAS8-37594)
(NASA-CR-183681; NAS 1.26:183681; RI/RD89-186) Avail: NTIS HC/MF A03 CSCL 13I

This program will focus on the integration of all functional disciplines of the design, manufacturing, materials, fabrication and producibility to define and demonstrate a highly reliable, easily maintained, low cost liquid methane turbopump as a component for the STBE (Space Transportation Booster Engine) using the STME (main engine) oxygen turbopump. A cost model is to be developed to predict the recurring cost of production hardware and operations. A prime objective of the program is to design the liquid methane turbopump to be used in common with a LH2 turbopump optimized for the STME. Time phasing of the effort is presented and interrelationship of the tasks is defined. Major subcontractors are identified and their roles in the program are described. E.R.

N91-24374*# Arizona Univ., Tucson. UA NASA SERC and Aerospace and Mechanical Engineering.
OXYGEN PLANT BREADBOARD DESIGN, AND TECHNIQUES FOR IMPROVING MISSION FIGURE-OF-MERIT
Kumar Ramohalli *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p Original contains color illustrations (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

N91-24375*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
THERMAL ANALYSIS, OPTIMIZATION AND DESIGN OF A MARTIAN OXYGEN PRODUCTION PLANT
Venkatesh A. Iyer and K. R. Sridhar *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 12 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

N91-24381*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
DEVELOPMENT AND MECHANICAL PROPERTIES OF STRUCTURAL MATERIALS FROM LUNAR SIMULANT
Chandra S. Desai *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

N91-24388*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
QUANTITATIVE SIMULATION OF EXTRATERRESTRIAL ENGINEERING DEVICES
A. Arabyan, P. E. Nikravesh, and T. L. Vincent *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 6 p Original contains color illustrations (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

N91-24389*# Arizona Univ., Tucson. Dept. of Electrical and Computer Engineering.
MODELING, SIMULATION, AND CONTROL OF AN EXTRATERRESTRIAL OXYGEN PRODUCTION PLANT
L. Schooley, F. Cellier, B. Zeigler, A. Doser, and G. Farrenkopf *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 6 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 13B

N91-25089*# Centre National d'Etudes Spatiales, Toulouse (France).
POST FLIGHT SYSTEM ANALYSIS OF FRECOPA (AO 138) Abstract Only
Christian Durin *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 123 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 13B

32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

N91-24472# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Avionics Panel.
ELECTRONIC COUNTER-COUNTER MEASURES FOR AVIONICS SENSORS AND COMMUNICATION SYSTEMS
Feb. 1991 116 p Symposium held in Ottobrunn, Fed. Republic of Germany, 1-5 Oct. 1990
(AGARD-CP-488; ISBN-92-835-0605-7) Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The performance of sensor and communication systems can be limited significantly by hostile Electronic Counter Measures (ECM). These include passive measures such as radar and laser

warning receivers, interception, emitter location systems as well as active measures such as jammers in various roles using different techniques and deception devices. Electronic Counter Countermeasures (ECCM) topics were addressed ranging from frequency agility to spread spectrum and data fusion techniques for both sensor and communications systems. For individual titles, see N91-24473 through N91-24483.

N91-24473# Shape Technical Center, The Hague (Netherlands).
A METHOD TO ENHANCE AZIMUTH ACCURACY BY THE USE OF THE A PRIORI KNOWLEDGE OF THE ANTENNA PATTERN
W. E. Hoekstra *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 8 p (For primary document see N91-24472 16-32)
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A method is presented to remove sidelobe contamination in antenna measurements for a circular scan antenna. Although the approach described is in principle only applicable to situations where the jamming is constant over one scan of data and requires perfect knowledge of the antenna pattern, it is shown that the method provides a substantial enhancement if these conditions are weakened. The mathematics used are not new, but this particular application might be. Author

N91-24474# Defence Research Establishment, Ottawa (Ontario). Radar Div.
ECCM ADVANTAGES OF ADAPTIVE DIGITAL PULSE COMPRESSION
Guy R. Painchaud and Martin Blanchette *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 8 p (For primary document see N91-24472 16-32)
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The Electronic Counter-Counter Measure (ECCM) advantages of an experimental adaptive digital pulse compression (DPC) system are described. This pulse compression system is implemented by a complex correlation between the transmitted waveform and the signal received by the radar. Central to the adaptability of this unit is the use of high speed VLSI digital ICs which permit bandwidths of up to 10 MHz, waveform or pulse code on each transmission. The DPC unit is intended to be used in a multifunction radar (MFR) which would employ many different waveforms. The objective is to describe how waveform adaptability can be used as an ECCM technique. Examples of its use as a counter-measure against both ESM (Electronic Support Measures) and ECM (Electronic Counter Measure) systems are given. Both denial and deceptive ECM are considered. Author

N91-24475# Magnavox Co., Fort Wayne, IN.
SATURN: THE NEXT GENERATION RADIO FOR NATO
James F. Keating and Thomas M. Schuerman *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 9 p (For primary document see N91-24472 16-32)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The Second Generation Antijam Tactical UHF Radio for NATO (SATURN) system is described along with the URC-126 radio which will meet SATURN requirements when it enters production for the USAF. As its name implies, the system approach was jointly developed with NATO countries as STANAG 4372. It is designed to meet UHF Voice and data communication requirements into the next century. The URC-126 radio will replace the ARC-164, and is being developed by the USAF as part of its Have Quick antijam program. The URC-126 will be the first of several SATURN radios. It has completed Full Scale Engineering Development and Qualification Testing using the USAF Have Quick 2A Fast Frequency Hopping (FFH) mode which is a precursor of SATURN. Production radios will have the full SATURN capability. The AF has also developed and qualified the GRC-234 which uses the Have Quick 2A FFH mode. Additionally, a SATURN radio is now in development for the European Fighter Aircraft (EFA). Author

N91-24476# Aerospace Corp., Los Angeles, CA.
OVERVIEW OF SURVIVABILITY TRADEOFFS FOR SELECTED ECCM WAVEFORMS
Donald P. Olsen *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 8 p (For primary document see N91-24472 16-32)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

While frequency spreading is the major contributor to antijam capability, it is usually of little help in nonfrequency selective scintillation caused by high altitude nuclear explosions or the natural ionosphere. The selection of modulation, coding, and interleaving parameters are the main determinants of a signal's performance in scintillation. These waveform features also influence the performance in jamming. The performance of slow frequency hopped waveforms is compared. The waveforms examined are the various combinations of modulation, coding, and decision type shown for DPSK and BPSK or MSK with rate 1/2 K = 7 convolutional coding or rate 1/4 concatenated coding and with hard or soft decisions. These comparisons are done for the environments of additive white Gaussian noise (AWGN), noise with scintillation, and for jamming. The performance differences range from 5 dB in AWGN to over 14 dB in certain inadequately interleaved partial band jamming cases. MSK with soft decision rate 1/4 coding outperformed DPSK with hard decision rate 1/2 coding in every case. Only the data communication and not the link acquisition waveforms is addressed. Author

N91-24477# Aerospace Corp., Los Angeles, CA.
CONCATENATED CODING WITH TWO LEVELS OF INTERLEAVING
Samuel Lim and Michael Newhouse *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 10 p (For primary document see N91-24472 16-32)
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A performance evaluation of an electronic counter counter measure (ECCM) communication system in a worst case partial band noise and partial band tone jamming scenario is documented. The ECCM communication system is composed of two levels of channel coding (concatenated coding) and two levels of interleaving. An analysis was performed for a concatenated code consisting of either a Reed-Solomon or a convolutional outer code and a conventional inner code, and the decoded bit error rates for typical binary modulation schemes (BPSK and DPSK) were obtained. The performance of these coded waveforms was compared with convolutionally encoded systems with respect to the required E sub b/N sub j to achieve an overall bit error rate of 10(exp -5). The results demonstrate a significant coding gain achievable from systems which adopt concatenated coding. Author

N91-24478# Draper (Charles Stark) Lab., Inc., Cambridge, MA.
ADVANCED ECCM TECHNIQUES FOR GPS PROCESSING
Edmund Balboni, John Dowdle, Joseph Przyjemski, and Ellen Mallery (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 12 p (For primary document see N91-24472 16-32)
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Two advanced Electronic Counter Countermeasures (ECCM) enhancement techniques were shown to greatly improve the antijam performance of Global Positioning System (GPS) receivers. The first method, Amplitude Domain Processing (ADP), is a nonlinear precorrelation processing technique which adapts to a changing ECM environment and exploits the statistical properties of strong nonGaussian jammers to significantly reduce their

effectiveness. ADP was demonstrated in hardware against a heavily jammed GPS signal; measured performance shows a reduction in continuous wave (CW), pulsed CW and swept CW jammer power of 36, 25, and 26 dB respectively. The second technique, Extended Range Adaptive Tracking, is a correlation process which optimally adjusts tracking loop bandwidths and multiple correlator weights in response to changing levels of GPS signal dynamics and ECM power levels. The extended range feature tolerates the growth of tracking error beyond the + or -1 chip conventional limit to + or -5 chips to guard against loss-of-lock under exceptionally severe combinations of jamming and dynamics. Analysis and simulations have shown that this technique can extend the receiver tracking threshold by an additional 26 dB. Author

N91-24479# Communications Research Centre, Ottawa (Ontario).
IMPROVING THE ECCM PERFORMANCE OF FAST FREQUENCY HOPPING BY DIVERSITY COMBINING
E. Barry Felstead and T. Aaron Gulliver (Defence Research Establishment, Ottawa, Ontario) *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 11 p (For primary document see N91-24472 16-32)
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The antijam performance of fast frequency hopping spread spectrum communications is proportional to the ratio of the spread bandwidth to the hop rate. In fast hopping, there are L greater than or = 1 hops per data symbol transmitted. In the presence of very strong jammers, improvement of the antijam performance may be required. Extra Electronic Counter CounterMeasure (ECCM) performance can be obtained by using the redundancy, L, in a process called diversity combining. To date, the predominant type of diversity combining uses some nonlinearity to reduce the effect of a very powerful jamming signal on a few of the L hops. Normalized envelope detection (NED) is the best example of this type. A new type, called the moment subtraction method, is introduced. Examples of both types are described and then error performance results are presented for very large noise and multitone jamming (SJR = 0 dB). It is found that bit error rates as high as 0.4 can be reduced to less than 0.1 for L less than 10 by both types of diversity combining and that one of the moment methods does even better than the baseline NED method.
Author

N91-24480# Shape Technical Center, The Hague (Netherlands). Communications Div.
AN OVERVIEW OF ECCM FACTORS IN MILSATCOM SYSTEMS
M. Safak *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 12 p (For primary document see N91-24472 16-32)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The relative significance of the factors affecting the Electronic Counter Countermeasure (ECCM) performance of MILSATCOM systems are identified and discussed. These factors are identified through the performance predictions for MILSATCOM systems, operating with geostationary satellites, under up- and downlink jamming. The factors influencing the system performance against signal exploitation and repeat back jamming are also discussed. A discussion is provided of the effects of the frequency of operation (SHF and EHF bands) on the ECCM factors. Author

N91-24481# Aerospace Corp., Los Angeles, CA.
PERFORMANCE OF MILSATCOM ADAPTIVE ANTENNA SYSTEMS IN PULSE JAMMER ENVIRONMENTS
W. B. Gail and Ira M. Weiss *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 6 p (For primary document see N91-24472 16-32)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

MILSATCOM antennas which use a linear gradient adaptive nulling algorithm to cancel interference respond differently to pulse jammers than to continuous wave (CW) jammers with the same peak output power. For a pulse jammer, the antenna adapts to cancel the interference when the jammer is on and recovers toward the unadapted state when the jammer is off. The adaptation time constants are approximately proportional to the received jammer signal power and the system noise respectively; the attack time constant is generally much smaller than the release time constant. An effective pulse jammer exploits this time dependence to prevent the antenna from fully cancelling the interference. For a particular antenna system, the worst case pulse jammer for a given waveform can be expected to occupy a well defined region of the operating space defined by the aspect angles, signal power, jammer power, duty cycle, and pulse repetition frequency (PRF). The effect of each of these parameters on antenna performance is studied for a multiple pulse jammer environment. The worst case operating space is identified for typical MILSATCOM antennas and the characteristics of the operating space are compared. Author

N91-24482# Aerospace Corp., Los Angeles, CA.
PERFORMANCE TRADEOFF OF MILSATCOM ADAPTIVE MULTIBEAM ANTENNAS
David H. Senensieb, Ira M. Weiss, and Young S. Kim *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 11 p (For primary document see N91-24472 16-32)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

MILSATCOM satellite communication applications may require servicing a collection of users distributed over a localized geographical area in the presence of interfering noise sources. Recent interest in such applications has focused on the use of adaptive nulling antennas to counter interference by shaping the radiation pattern in response to the signal environment. The nulling performance of gimballed multibeam antennas (GMBAs) are compared for hexagonal and square feed arrangements for two reflector diameters. Performance is characterized by the percent of the coverage area available for communication parameterized by data rate (area coverage mode) and by user/jammer separation resolution (spot beam mode). Author

N91-24483# Wright Research Development Center, Wright-Patterson AFB, OH.
A MODULATION QUALITY FACTOR FOR LOW PROBABILITY OF INTERCEPT (LPI) COMMUNICATIONS SYSTEMS
Glenn Prescott (Kansas Univ., Lawrence.), Lawrence Gutman, and Dan Connolly *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems Feb. 1991 6 p (For primary document see N91-24472 16-32)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

LPI (low probability of intercept) system quality factors were developed in a previous effort in order to provide a quantitative analysis tool for the system engineer to employ in evaluating the effectiveness of LPI techniques in the presence of jammers and intercept receivers. These LPI system quality factors were derived from the system link equations which describe the signal power gains and losses as a function of system link parameters. The issue is examined of LPI modulation by defining the modulation quality factor. The LPI modulation quality factor is a measure of the covertness of a particular type of modulation when detection is attempted by a particular type of intercept receiver. The utility of this quality factor is illustrated by examples and performance curves which demonstrate the concept. Author

N91-24484# National Inst. of Standards and Technology, Boulder, CO. Electromagnetic Fields Div.
SPHERICAL NEAR-FIELD SCANNING: EXPERIMENTAL AND THEORETICAL STUDIES
Ronald C. Wittmann and Carl F. Stubenrauch Jul. 1990 87 p
Sponsored by RADC, Hanscom AFB, MA

(PB91-132274; NISTIR-3955) Avail: NTIS HC/MF A05 CSCL 20N

The evaluation of spherical near-field scanning algorithms and the computer code developed at the National Institute of Standards and Technology is presented. The experimental work is primarily a comparison of probe-compensated spherical and planar near-field measurement results for a common test antenna. Theoretical work is largely supportive of the experimental effort, but some peripheral topics are developed and include: (1) application of spherical near-field measurements to the determination of incident fields in compact ranges; and (2) spherical-wave expansions for the fields of a uniformly excited circular aperture (to facilitate the creation of analytic test data). GRA

N91-24485*# Michigan Univ., Ann Arbor. Radiation Lab.
APPLICATIONS OF THE CONJUGATE GRADIENT FFT METHOD IN SCATTERING AND RADIATION INCLUDING SIMULATIONS WITH IMPEDANCE BOUNDARY CONDITIONS
Technical Report, Feb. - Sep. 1991
Kasra Barkeshli and John L. Volakis May 1991 285 p
(Grant NAG2-541)
(NASA-CR-188214; NAS 1.26:188214; UM-025921-21-T) Avail: NTIS HC/MF A13 CSCL 20N

The theoretical and computational aspects related to the application of the Conjugate Gradient FFT (CGFFT) method in computational electromagnetics are examined. The advantages of applying the CGFFT method to a class of large scale scattering and radiation problems are outlined. The main advantages of the method stem from its iterative nature which eliminates a need to form the system matrix (thus reducing the computer memory allocation requirements) and guarantees convergence to the true solution in a finite number of steps. Results are presented for various radiators and scatterers including thin cylindrical dipole antennas, thin conductive and resistive strips and plates, as well as dielectric cylinders. Solutions of integral equations derived on the basis of generalized impedance boundary conditions (GIBC) are also examined. The boundary conditions can be used to replace the profile of a material coating by an impedance sheet or insert, thus, eliminating the need to introduce unknown polarization currents within the volume of the layer. A general full wave analysis of 2-D and 3-D rectangular grooves and cavities is presented which will also serve as a reference for future work. Author

N91-24486# National Telecommunications and Information Administration, Washington, DC.
TELECOMMUNICATIONS NETWORKS: SERVICES, ARCHITECTURES, AND IMPLEMENTATIONS
R. F. Linfield Dec. 1990 121 p
(PB91-151852; NTIA-90-270) Avail: NTIS HC/MF A06 CSCL 17B

Telecommunication networks are shown to exhibit three attributes that distinguish them from each other: (1) the service offered; (2) the functional architecture necessary to provide the service; and (3) the hardware and software that implements the architecture. For each service there are many possible architectures and for each architecture there are many possible implementations. A basic understanding of the services, architectures, and technologies that are the foundation of advanced telecommunication networks is provided. GRA

N91-24487# National Telecommunications and Information Administration, Washington, DC.
SPECTRUM REQUIRED FOR HF BROADCASTING
J. Washburn, G. Hand, L. Berry, and J. Ratzloff Oct. 1990 99 p
(PB91-151860; NTIA-90-268) Avail: NTIS HC/MF A05 CSCL 17B

Estimates of the minimum amount of spectrum needed in the high-frequency (HF) bands are made for satisfying worldwide broadcasting requirements. The analysis provides technical bases for the U.S. allocation proposals being developed in preparations for the World Administrative Radio Conferences (WARC) to be held in 1992 and 1993. The analysis applies to the ITS developed HF spectrum use model (HFSUM) software to compute the minimum number of channels needed to assure specified levels of broadcast quality for both the existing double-sideband (DSB) and the proposed compatible single-sideband (SSB) systems. The HFSUM software produces definitive results for the existing DSB systems and for the spectrum needs of the proposed compatible SSB systems. The results obtained in the analysis when considering all HF bands indicate that the existing DSB system needs approximately three to four times as much HF spectrum as that currently allocated to broadcasting. GRA

N91-24488# National Inst. of Standards and Technology, Boulder, CO. Electromagnetic Fields Div.
NEAR-FIELD AND FAR-FIELD EXCITATION OF A LONG CONDUCTOR IN A LOSSY MEDIUM
D. A. Hill Sep. 1990 38 p Sponsored by Army
(PB91-143347; NISTIR-3954) Avail: NTIS HC/MF A03 CSCL 20N

Excitation of currents on an infinitely long conductor is analyzed for horizontal electric dipole or line sources and for a plane-wave, far-field source. Any of these sources can excite strong currents which produce strong scattered fields for detection. Numerical results for these sources indicate that long conductors produce a strong anomaly over a broad frequency range. The conductor can be either insulated or bare to model ungrounded or grounded conductors. GRA

N91-24489*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SCIENCE PROGRAM FOR AN IMAGING RADAR RECEIVING STATION IN ALASKA. REPORT OF THE SCIENCE WORKING GROUP
1 Dec. 1983 57 p Original contains color illustrations
(NASA-CR-188194; NAS 1.26:188194) Avail: NTIS HC/MF A04; 2 functional color pages CSCL 17I

It is argued that there would be broad scientific benefit in establishing in Alaska an imaging radar receiving station that would collect data from the European Space Agency's Remote Sensing Satellite, ERS-1. This station would acquire imagery of the ice cover from the American territorial waters of the Beaufort, Chukchi, and Bering Seas. This station, in conjunction with similar stations proposed for Kiruna, Sweden, and Prince Albert, Canada would provide synoptic coverage of nearly the entire Arctic. The value of such coverage to aspects of oceanography, geology, glaciology, and botany is considered. Author

N91-24490 Department of the Navy, Washington, DC.
VIDEO DELTA MODULATION ENCODER Patent
George T. Mills, inventor (to Navy) 8 Jan. 1991 8 p Filed 13 Oct. 1989
(AD-D014833; US-Patent-4,983,972; US-Patent-Appl-SN-422315; US-Patent-Class-341-143) Avail: US Patent and Trademark Office CSCL 09/1

In a continuously variable slope delta modulation encoder or decoder, the slope of a reconstructed signal is varied by selecting the charging voltage across an integrating capacitor. For an NTSC video signal, the charging voltage may be selected by a shift register connected to a voltage divider supplying the integrating capacitor. In an integrating circuit for a multi-slope delta modulation encoder or decoder, the charging voltage across an integrating capacitor is selected to vary the slope of a reconstructed signal which, in an encoder, is compared with the input signal to determine the next bit of the encoded signal. For use with an NTSC video signal, the charging voltage is, preferably, selected by a shift register receiving the encoded signal and retaining the current and immediately previous bits thereof. The shift register receiving the encoded signal and retaining the serve selectively as sources or sinks for a voltage divider through which the integrating capacitor charges to integrate the encoded signal. An object of the present invention is to provide a compact and light weight multi-slope delta modulation encoder requiring low power. GRA

N91-24491# Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ. Fire Support Armament Center.

THEORY OF ELECTROMAGNETIC SHIELDING FOR CONDUCTING CYLINDERS AND SPHERES Final Report, Jan. - Dec. 1989

John Podesta Mar. 1991 120 p

(AD-A233261; ARFSD-TR-90027) Avail: NTIS HC/MF A06 CSCL 09/7

The shielding of electromagnetic waves by cylindrical and spherical enclosures is analyzed. The electromagnetic shielding effectiveness is calculated as a function of frequency for a plane wave incident on hollow cylindrical and spherical conducting shells. The electromagnetic resonances for the cylinder and the sphere are investigated and the resonance conditions are derived for both structures. In addition, a simple asymptotic formula for the shielding effectiveness is developed which is a good approximation in the resonance regime. Numerical calculations are performed for both the cylinder and the sphere, and the shielding effectiveness is plotted as a function of frequency for a shield with an outer diameter of 155 mm, a thickness of 0.1 mm, and a conductivity of 10 to the 7th per ohm per meter. GRA

N91-24492# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, The Hague (Netherlands). Physics and Electronics Lab.

RESULTS OF THE PROPAGATION MEASUREMENTS OVER A 5120 m LINK OVER LAND AT 94 GHz Final Report

F. J. Klumpers Jan. 1991 44 p

(AD-A233405; FEL-90-B340; TDCK-TD-90-4051) Avail: NTIS HC/MF A03 CSCL 20/14

In 1983, a 94 GHz propagation experiment was carried out during a period of 6 months over a line of side link from Den Haag to Leidschendam. This experiment was perform to verify the theoretical models of S.H. Lin and to verify the results of a study done by Buijs, concerning the models of Lin for higher frequencies. The models of Lin can be used to calculate the lognormal distribution of rain rate and attenuation, using the data of only one rain-rate meter placed near the transmitter or the receiver with an 'infinitely' long link. This model was not yet tested for high frequencies, like 94 GHz. Although the weather in the Netherlands was not very characteristic during this experiment due to much rainfall, the models of Lin corresponded very well with the experimental results. The theoretical results of Buijs did not meet the measured for several reasons: the most important being the bad weather of that time. GRA

N91-24493# Defence Research Establishment, Ottawa (Ontario).

HOPPING SYNTHESIZER CONTROLLER

Robin Addison Aug. 1990 79 p In ENGLISH and FRENCH

(AD-A233428; DREO-TN-90-17) Avail: NTIS HC/MF A05 CSCL 17/4

The EHF SATCOM (Extremely High Frequency Satellite Communications) project includes a contract in industry for a ground-based model of a frequency hopping spread spectrum satellite communications system. There is also an in-house effort in key technical areas. One requirement is a Hopping Synthesizer Controller to drive a frequency synthesizer, and is the subject of this report. The controller was built on a single board using a digital signal processor for calculations and an erasable programmable logic device for interfacing. It provides the pseudo-random hopping sequence, modulation, channel selection and Doppler precorrection. The Hopping Synthesizer Controller can drive the frequency synthesizer at hop rates up to 25 khops/s. Four configurations are supported: operation within either the payload or ground terminal simulator, for uplink or downlink. Each configuration supports commands from a Synchronization Controller and a special synchronization mode. In this document the software and hardware details are provided along with a user guide for the board. GRA

N91-24494# Naval Ocean Systems Center, San Diego, CA.

EVAPORATION DUCT COMMUNICATION: TEST PLAN Final Report, Oct. 1989 - Oct. 1990

K. D. Anderson Feb. 1991 25 p

(AD-A233467; NOSC/TD-2033) Avail: NTIS HC/MF A03 CSCL 25/5

The Evaporation Duct Communication (EDCOM) project is an effort to provide an alternative ship-to-ship communications channel using the natural environment. A microwave communication link can be used on an over-the-water, over-the-horizon path through the evaporation duct. This report shows how a microwave communication link, operating at a range separation of more than twice the line-of-sight range, can be constructed. This link can achieve about 80-percent availability at a transmission frequency of 14.5 GHz and can be constructed using off-the-shelf RF equipment. Operation of this link will provide the first set of measurements of channel capacity that can be critically dependent on the existence of an oceanic evaporation duct. Construction of this link presents a unique opportunity to study and evaluate an alternative communications channel that can be used to alleviate naval battlegroup communications load. GRA

N91-24495# Battelle Columbus Labs., OH. Tactical Technology Center.

ASSESSMENT OF ULTRA-WIDEBAND (UWB) TECHNOLOGY Summary Report

13 Jul. 1990 32 p

(Contract DAAH01-88-C-0131)

(AD-A233624; R-6280-S) Avail: NTIS HC/MF A03 CSCL 17/9

The panel concentrated on radar but invited the presentation of ideas on communications. No ideas or proposals for UWB communications systems or techniques were presented, nor were any advantages for such systems apparent to the Panel. Examination of electronic warfare and RF weaponization applications was very limited. The restrictions imposed by the combination of security classification and the proprietary nature of many of the EW and weaponization concepts under development by the presenters made it difficult for the panel to conduct an in depth review of these areas. Further, the DoD has established a separate in-house committee to review a broader area that includes UWB applications to electronic warfare and weaponization. Thus, the panel's efforts were almost entirely devoted to UWB radar issues. GRA

N91-24496# Argonne National Lab., IL.

CTD WRITING AND EDITING STANDARDS

C. M. Caruthers Mar. 1991 72 p

(Contract W-31-109-eng-38)

(DE91-010327; ANL/TM-487) Avail: NTIS HC/MF A04

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N91-24497# Sandia National Labs., Albuquerque, NM.
BOREHOLE RADAR FOR GEOTHERMAL APPLICATIONS
M. W. Scott and T. W. H. Caffey 1991 10 p Presented at the 9th Geothermal Program Review: The Geothermal Partnership--Industry, Utilities and Government Meeting the Challenges of the 1990's, San Francisco, 19-21 Mar. 1991
(Contract DE-AC04-76DP-00789)
(DE91-010478; SAND-91-0642C; CONF-9103105-2) Avail: NTIS HC/MF A02

An initial evaluation of a continuous wave borehole radar system with steerable antennas has been completed. Candidate antennas have been identified which meet the size requirements for borehole applications. The patterns of these antennas are not dependent on the properties of the surrounding media when the antenna dimensions are less than one-tenth wavelength. The beam patterns can be steered adequately to allow the volume of earth within several meters of a borehole to be investigated. DOE

N91-24668# Meteorological Satellite Center, Tokyo (Japan).
SCINTILLATION OBSERVED ON THE GMS COMMUNICATION LINK
Hiroshi Tomita *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 73-85 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

N91-25083*# Grumman Aerospace Corp., Bethpage, NY.
EFFECTS OF SPACE ENVIRONMENT ON SPACE-BASED RADAR PHASED-ARRAY ANTENNA: STATUS AND PRELIMINARY OBSERVATIONS Abstract Only
J. B. Whiteside, D. Giangano, R. L. Heuer, E. Kamykowski, M. Kesselman, W. Rooney, R. Schulte, and Michael C. Stauber *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 117 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20N

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

N91-24498# Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
APPLICATION OF LIGHTNING ARRESTER ON TRANSMISSION LINES
K. Matsubara May 1990 31 p In JAPANESE; ENGLISH summary
(DE91-764239; CRIE-T-89067) Avail: NTIS HC/MF A03

A lightning arrester on transmission lines is expected to reduce lightning incidents; however, the problems of the application guide to be established such as the method of application, the treating capacity for lightning energy, and the coordination to an arc horn remain as they are. The method of application for a lightning arrester on transmission lines and its effect are examined from the viewpoint of the generating incident on transmission lines by lightning and the operating viewpoint of a lightning arrester for a 77kV system. The double circuit setup of an arrester is the best method to reduce the lightning incidents and the single circuit setup can reduce the incident rate by 40 percent preventing the flashover of the circuit on which the arrester is not set up. For installing an arrester on a short section, the flashover point can transfer to the next steel tower where the arrester is not set up, only when lightning strikes the last steel tower. Inflowing current into an arrester from a direct lightning strike is considerably large and the energy at that time becomes large but this energy can be reduced by the operation of the arrester set up on another steel tower. DOE

N91-24499*# Texas Univ., Austin. Dept. of Electrical and Computer Engineering.
ANALYSIS AND CHARACTERIZATIONS OF PLANAR TRANSMISSION STRUCTURES AND COMPONENTS FOR SUPERCONDUCTING AND MONOLITHIC INTEGRATED CIRCUITS Final Report, 1 Oct. 1989 - 12 Nov. 1990
Tatsuo Itoh 5 Jun. 1991 21 p
(Contracts NCC3-192; N00014-89-J-1006)
(NASA-CR-188213; NAS 1.26:188213) Avail: NTIS HC/MF A03 CSCL 09C

The analysis and modeling of superconducting planar transmission lines were performed. Theoretically, the highest possible Q values of superconducting microstrip line was calculated and, as a result, it provided the Q value that the experiment can aim for. As an effort to search for a proper superconducting transmission line structure, the superconducting microstrip line and coplanar waveguide were compared in terms of loss characteristics and their design aspects. Also, the research was expanded to a superconducting coplanar waveguide family in the microwave packaging environment. Theoretically, it was pointed out that the substrate loss is critical in the superconducting transmission line structures. Author

N91-24500# Royal Aircraft Establishment, Farnborough (England).
THE RHEOLOGICAL BEHAVIOUR AND THIXOTROPY OF ELECTRORHEOLOGICAL SUSPENSIONS IN DIFFERING TEMPERATURE/VELOCITY CONDITIONS
E. V. Korobko, A. D. Matsepuro, and I. P. Krasnikova Oct. 1990 12 p Transl. into ENGLISH from Vesti Akadmii Navuk BSSR, Ser. Fiz-Energ. Navuk (Minsk, USSR), no. 2, 1989 p66-71
(RAE-Lib-Trans-2182; BR300771) Avail: NTIS HC/MF A03

Measurements are made of the dynamic moduli of strain development G' and losses G'' in highly concentrated electrorheological aerosol and diatomite in transformer oil under low amplitude strain conditions. The moduli G' and G'' are compared, and do not depend on the angular frequency, omega, up to high values of omega, and increase with electric field strength, particle concentration and temperature. Author

N91-24501*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SELECTION OF WIRES AND CIRCUIT PROTECTIVE DEVICES FOR STS ORBITER VEHICLE PAYLOAD ELECTRICAL CIRCUITS
Darilyn M. Gaston Jun. 1991 37 p
(NASA-TM-102179; S-629; NAS 1.15:102179) Avail: NTIS HC/MF A03 CSCL 09C

Electrical designers of Orbiter payloads face the challenge of determining proper circuit protection/wire size parameters to satisfy Orbiter engineering and safety requirements. This document is the result of a program undertaken to review test data from all available aerospace sources and perform additional testing to eliminate extrapolation errors. The resulting compilation of data was used to develop guidelines for the selection of wire sizes and circuit protection ratings. The purpose is to provide guidance to the engineering to ensure a design which meets Orbiter standards and which should be applicable to any aerospace design. Author

N91-24502# Intercon Systems Corp., Alexandria, VA.
CATHODE LIFE TEST FACILITY USERS MANUAL OPERATING AND MEASUREMENT PROCEDURES Final Report
Robert Macior, Rocco Mesagna, and Ronald Jardieu Dec. 1990 52 p Prepared in cooperation with Atlantic Research Corp., Rome, NY
(Contract F30602-89-D-0028)
(AD-A232506; RADC-TR-90-333) Avail: NTIS HC/MF A04 CSCL 09/1

This report is designed to be a users manual describing the

operating and measurement procedures required to conduct life test experiments on thermionic cathodes, within the RADC Cathode Life Test Facility. The Cathode Life Test Facility located at Griffiss Air Force Base is designed for determining the degradation characteristics of cathode emitters. Through the use of this facility, Rome Air Development Center conducts life test measurements on various types of thermionic cathodes. The facility is presently equipped with 40 power supplies, 38 of which were manufactured by Cober Electronics and 2 which were designed by RADC. A Liebert Corporation A/C Aircooled R-22 unit is capable of maintaining constant temperature and relative humidity independent of weather conditions. GRA

N91-24503# California Univ., Berkeley. Electronics Research Lab.
JOINT SERVICES ELECTRONICS PROGRAM Annual Progress Report, 6 Jun. 1990 - 28 Feb. 1991
Chenming Hu and Michael Lieberman 5 Mar. 1991 55 p
(Contract F49620-90-C-0029)
(AD-A232855; UCB/ERL-90/1) Avail: NTIS HC/MF A04 CSCL 09/1

This document is the 1990 annual report of research conducted in the Electronics Research Laboratory at University of California at Berkeley under the sponsorship of the Joint Services Electronics Program. The following topics are discussed: (1) nonlinear optics in compound semiconductors; (2) ultrafast optical techniques; (3) optical probing of semiconductor devices and interfaces by electro-optic and photoelastic effects; (4) micron BiCMOS devices in bulk and SOI substrates; (5) conductive oxides and ferroelectrics for programmable devices; (6) insulated gate GaAs filed effect transistors; (7) stochastic neural networks and application to signal processing; (8) learning and generalization by neural networks; and (9) architectural issues in parallel computation with respect to neural networks. GRA

N91-24504# State Univ. of New York, Buffalo. Dept. of Electrical and Computer Engineering.
MULTIFACTOR STRESS AGING OF ELECTRICAL INSULATION Final Report, 1 Feb. 1989 - 30 Sep. 1990
Javaid R. Laghari 29 Nov. 1990 38 p
(Grant AF-AFOSR-0272-89)
(AD-A232915; AFOSR-91-0124TR) Avail: NTIS HC/MF A03 CSCL 09/1

Capacitor-grade polypropylene films were aged under multiple stresses (electrical, thermal, radiation) using a 2MW thermal nuclear reactor. Thermal and electrical stresses were found to slightly decrease both the AC and DC breakdown voltages. Radiation stresses were found to increase the breakdown voltages. The same trends were seen in volume resistivity. The radiation effects dominate both the thermal and electrical effects and are attributed to increased crystallinity of the polypropylene. However, mechanical properties are significantly degraded by radiation damage, and degree of breakdown enhancements are seen for combined stresses. Computer simulation has been performed showing the magnitude of the neutrine signal from a 100 kilocurie tritium source, under the geometrical conditions of the experiments at Los Angeles National Laboratory, TA-33, is about an order of magnitude smaller than the gravity signal from a 2600 gr mass (the assumed value for the mass of the source). The observations were performed by using Professor Joe Weber's torsion balance, a room-temperature instrument. GRA

N91-24505# Department of the Navy, Washington, DC.
MAGNETOSTRICTIVE LINEAR MOTOR Patent Application
Joseph P. Teter, inventor (to Navy) and Arthur E. Clark, inventor (to Navy) 11 Oct. 1990 19 p
(AD-D014816; US-Patent-Appl-SN-607350) Avail: NTIS HC/MF A03 CSCL 11/7

The magnetostrictive rod of a linear motor is made of the twinned single crystal Terfenol-D. Its crystalline axis is aligned with the rod axis to produce non-uniform transverse magnetostriction during axial magnetostrictive elongation of the rod in response to a triggering magnetic field. Slide bearing forces applied through spring biased support plates are limited to flat surfaces formed on the rod perpendicular to a transverse axis along which the rod is magnetostrictively contracted. GRA

N91-24506 Department of the Navy, Washington, DC.
SOLID STATE SEQUENCING SWITCH Patent
Eugene R. Roeschlein, inventor (to Navy) 15 Jan. 1991 9 p Filed 26 Apr. 1971
(AD-D014831; US-Patent-4,985,874; US-Patent-Appl-SN-137599; US-Patent-Class-367-122) Avail: US Patent and Trademark Office CSCL 09/1

A combination of integrated circuit (IC) flatpacs is used in combination to switch selected sonar microphone inputs from a circular receiving array to position a beam containing a sounding target intermediate to an equal number of left and right microphone pickups. It selectively switches through weighted delay circuits for beam forming to present the target in this receiving beam electronically on a flat display with digital control of coarse seven and one-half degrees and fine one-tenth degree increments to provide a display of the bearing of the target. GRA

N91-24507# Mitre Corp., Bedford, MA.
ELECTRICALLY-SMALL QUARTER-WAVE, AND RESONANT MONOPOLE ELEMENTS WITH DISK GROUND PLANS IN FREE SPACE Final Report
M. M. Weiner Dec. 1990 18 p
(AD-A233062; M90-93) Avail: NTIS HC/MF A03 CSCL 09/1

This paper extends previously reported results for a quarterwave monopole element on a disk ground plane in free space to include electrically-small and resonant elements. Numerical results are obtained by utilizing Richmond's method of moments computer program for disk ground planes in free space. GRA

N91-24508# General Electric Co., Utica, NY. Aerospace Electronic Systems Dept.
QUALIFICATION PROCEDURES FOR VHSIC/VLSI Final Technical Report, Sep. 1986 - Aug. 1989
Thomas A. Baumes Dec. 1990 161 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Contract F30602-86-C-0172)
(AD-A233110) Avail: NTIS HC/MF A08 CSCL 09/1

This program developed, outlined, refined, and verified the test methodology and qualification criteria and procedures to be used to ensure the integrity and reliability of microcircuit devices designed for insertion into military systems. A major portion of the criteria and procedures, reflected herein, enables a significant reduction in time and cost of the microcircuit Quality/Reliability Assurance process by addressing up front simulations during design prior to commitment, complex and expensive manufacturing processes with in-line quality processes controlled by a SPC (Statistical Process Control) program and ongoing QA Program using their TRB (Technology Review Board) and SEC (Standard Evaluation Circuit) programs. GRA

N91-24509# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry.
ELECTROCATALYTIC OXIDATION OF METHANOL BY ASSEMBLIES OF PLATINUM/TIN CATALYST
Christopher T. Hable and Mark S. Wrighton Mar. 1991 24 p
(Contract N00014-84-K-0553)
(AD-A233291; TR-43) Avail: NTIS HC/MF A03 CSCL 09/1

Oxidation of methanols at electrodes modified with polyaniline and Pt/Sn particles has been studied in aqueous H2SO4 electrolyte at 298 K. The Pt/Sn particles have been deposited into the polyaniline by electrochemical deposition from aqueous H2SO4 containing Pt(IV) and Sn(IV) from addition of K2PtCl6 and SnCl4.5H2O, respectively. The activity for MeOH oxidation is higher than that of polyaniline-coated electrodes modified with Pt alone. The highest catalytic activity is observed for Pt alone. The highest catalytic activity is observed for Pt/Sn particles that are codeposited from solutions containing 7 mM Sn (IV) when a 3 mM Pt (IV) solution is used. GRA

N91-24510# Stanford Univ., CA. Dept. of Electrical Engineering.
LINEAR CONTROLLER DESIGN VIA INFINITE CONVEX OPTIMIZATION Final Report, 1 Dec. 1988 - 30 Nov. 1990
Stephen Boyd 17 Jan. 1991 11 p
(Grant AF-AFOSR-0228-89)
(AD-A233335; SU-SPO-35887; AFOSR-91-0212TR) Avail: NTIS HC/MF A03 CSCL 09/1

The linear controller design problem was reformulated as a convex optimization problem, which may be more easily solved than the problems resulting from more conventional formulations. This reformulation has several unconventional aspects: it synthesizes control laws that have high degree, but nevertheless can be implemented using digital signal processors; the solution is rarely expressed in a closed-form, but nevertheless is readily computable. The results of this research are described in general terms. Full details can be found in the references cited. GRA

N91-24511# Naval Ocean Systems Center, San Diego, CA.
LASER PROCESSING OF SILICON ON SAPPHIRE (SOS) FOR FABRICATION OF BIPOLAR TRANSISTORS Final Report, 1 Oct. 1989 - 30 Sep. 1990
B. W. Offord, S. D. Russell, and K. H. Weiner Nov. 1990 31 p
(AD-A233390; NOSC/TR-1376) Avail: NTIS HC/MF A03 CSCL 09/1

Nanosecond thermal processing using an excimer laser was used in fabrication of NPN bipolar transistors in silicon-on-sapphire (SOS). Functional devices with current gain approaching 100 were obtained. The deleterious effects of diffusion pipes in SOS material were minimized using rapid laser activation of in implanted dopant. Details of the device design fabrication, and test results are included in this report. GRA

N91-24512# Goffman (Martin) Associates, Edison, NJ.
NIOBIUM NITRIDE JOSEPHSON JUNCTION STUDIES AND DEVICES Final Report, 1 Jul. - 31 Dec. 1990
W. R. Sinclair 26 Feb. 1991 18 p
(Contract F49620-90-C-0037)
(AD-A233418; AFOSR-91-0206TR) Avail: NTIS HC/MF A03 CSCL 09/1

We suggest here a novel class of molecules for use in making monolayer thick insulating barriers for Josephson junctions employing all NbN conductors. For the experiments discussed here the smallest member of that class has been chosen. From sessile drop experiments we determine that this compound indeed reacts with NbN as postulated. Measurements of the electrical properties are less definitive. In no couple is shorting noted but the super conductivity of the bottom layer is eliminated near the junction presumably due to diffusion of the reactant molecule into the film. GRA

N91-24513# Defence Research Establishment, Ottawa (Ontario).
COMPUTER SIMULATION OF PHOTOCURRENTS IN P-N JUNCTIONS USING RADSPICE
G. T. Pepper and R. E. Stone Dec. 1990 40 p In ENGLISH and FRENCH
(AD-A233427; DREO-1063) Avail: NTIS HC/MF A03 CSCL 09/1

Computer-aided engineering (CAE) tools such as SPICE (Simulation Program with Integrated Circuit Emphasis) have been successfully used for almost three decades to simulate the electrical performance of electronic devices and circuits. One such simulation program, RADSPICE, has the added feature of being able to simulate a useful range of radiation effects in electronics. This report investigates the simulation techniques used in RADSPICE for modelling photocurrents produced by the interaction of ionizing radiation in p-n junctions. Using photocurrent modelling techniques, a method for creating and simulating a radiation hardened (for space radiation effects) complementary metal oxide semiconductor (CMOS) static random access memory (SRAM) is illustrated. GRA

N91-24514# Department of the Navy, Washington, DC.
METAL-GLASS COMPOSITE FIELD-EMITTING ARRAYS Patent Application
Jack D. Ayers, inventor (to Navy) 1 Nov. 1990 19 p
(AD-D014850; US-Patent-Appl-SN-607955) Avail: NTIS HC/MF A03 CSCL 09/1

A field emitting array is provided which comprises at least one thin wafer having electrically conducting filaments extending through a glass matrix between a first and second parallel surface of the wafer. At the first surface, the filaments extend beyond the plane of the glass matrix. The filaments extending beyond the first surface have an electron emitting coating on their cylindrical surfaces. The coating extends beyond the filament end to create a shape that emits electrons when an electrical field is applied between the filaments and an anode. In an alternative embodiment, the filaments are recessed below the first surface and a conducting coating forms an extractor on that surface. GRA

N91-24515# Sandia National Labs., Albuquerque, NM.
PROCEDURES USED IN THE CALIBRATION OF ac CALIBRATORS
M. T. Salazar Feb. 1991 36 p
(Contract DE-AC04-76DP-00789)
(DE91-009853; SAND-90-0905) Avail: NTIS HC/MF A03

An automatic calibration system used in the calibration of all precision ac calibrators is described. The system includes an ac-dc Transfer Standard, a dc Voltage Standard, and a high resolution digital multimeter, with an IBM-XT Personal Computer for data acquisition and analysis. Specialized instrumentation and measurement techniques make it possible to achieve high accuracy measurements with repeatability. DOE

N91-24516# Oak Ridge National Lab., TN.
DESIGN AND PERFORMANCE OF AN AXIAL AIR-GAP SOLUTION PUMP MOTOR
R. A. Hawsey, C. W. Sohns, D. S. Daniel, and J. M. Bailey (Tennessee Univ., Knoxville.) May 1990 31 p
(Contract DE-AC05-84OR-21400)
(DE91-009988; ORNL/ATD-36) Avail: NTIS HC/MF A03

An axial air gap, permanent magnet, brushless dc motor was designed and was evaluated on a dynamometer to measure operating characteristics. The motor must deliver 0.167 hp (approx. 120 W) to the pump rotor at 1800 rpm. Initial performance data with a half-bridge, Hall-probe synchronized drive system and a dry motor bearing did not achieve the desired motor performance. Subsequently, a commercial full-bridge, speed regulated sensorless drive system was used to test the motor. The motor delivered the required 90 oz-in. of torque at 1800 rpm. These data revealed the need for rewinding the stator core to improve motor efficiency. A second stator core, with deeper slots and additional turns of wire, was subsequently fabricated and tested. At 1800 rpm, the drive system could produce only 60 oz-in. of torque due to an unexpectedly high generated voltage. Motor efficiency was 60 to 70 pct. at this torque level when the data were corrected for bearing and coupling drag. DOE

N91-24517# Gandhi (Indira) Centre for Atomic Research, Kalpakkam (India).
GLOW DISCHARGE LAMP: A LIGHT SOURCE FOR OPTICAL EMISSION SPECTROSCOPY
K. S. Vishwanathan, V. Srinivasan, S. Nalini, and T. R. Mahalingam 1990 28 p
(DE91-619433; IGC-113) Avail: NTIS HC/MF A03

A glow discharge lamp based on a modified version of the Grimm design has been fabricated. Its utility as a radiation source for optical emission spectrography by standardizing a method for the analysis of low alloy steels using a set of certified standards from DMRL, Hyderabad, has been demonstrated. A model has been proposed where the sputtering rates of different metals have been correlated with their heats of sublimation, metallic radii, and densities. Sputtering rates of ten different metals obtained from literature have been used to test this model, and the correlation appears to be excellent. DOE

N91-24518# California Univ., Berkeley. Dept. of Materials Science and Mineral Engineering.
PHYSICAL MODELING OF BUBBLE PHENOMENA, ELECTROLYTE FLOW, AND MASS TRANSFER IN SIMULATED ADVANCED HALL CELLS
J. W. Evans and R. Shekhar Jul. 1990 75 p
(Contract DE-AC07-76ID-01570)
(DE91-009816; DOE/ID-10281-Add) Avail: NTIS HC/MF A04

The final report, to which this report is an addendum, described results obtained in a physical model of an advanced Hall cell using inert anodes and wettable cathodes. The data were predominantly from measurement of the simulated electrolyte velocities obtained using a laser Doppler velocimeter, and were for three anode designs: a near-vertical grooved anode, a horizontal/near-horizontal grooved anode, and a horizontal/near-horizontal flat anode. This addendum to the final report contains results for an improved near-horizontal anode, together with some results from the other three anodes for comparison purposes. In addition to velocity measurements, the results in this addendum include measurements of mass transfer rates (at the cathode) and interpolar resistance. This investigation was concluded by taking videotapes of the bubbles at the faces of gas-evolving anodes to demonstrate the advantage of the grooved anode designed to facilitate the entry of the gas bubbles into the grooves. DOE

N91-25064*# TRW, Inc., Redondo Beach, CA. Space and Technology Group.
LDEF SP-HVDE (SPACE PLASMA-HIGH VOLTAGE DRAINAGE EXPERIMENT) POST-FLIGHT DATA ON SPACECRAFT LEAKAGE CURRENT AND DISCHARGE Abstract Only
J. Y. Yaung, W. C. Wong, B. K. Blakkolb, and L. E. Ryan *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 98 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 09C

N91-25084*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SYSTEMS SPECIAL INVESTIGATION GROUP OVERVIEW Abstract Only
James B. Mason, Harry Dursch, and Joel Edelman (Long Duration Exposure Facility Newsletter, Silver Spring, MD.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 118 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 09C

N91-25085*# Boeing Aerospace and Electronics Co., Seattle, WA.
LDEF ELECTRONIC SYSTEMS: SUCCESSES, FAILURES, AND LESSONS Abstract Only
Emmett Miller, Dave Porter, Dave Smith, Larry Brooks, Joe Levorsen, and Owen Mulkey *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 119 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 09C

N91-25090*# Aerospatiale, Cannes (France).
EFFECTS OF ULTRAVACUUM AND SPACE ENVIRONMENT ON CONTACT OHMIC RESISTANCE (AO 138-11) Abstract Only
Jean Pierre Assie and Alfred Perotto *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 124 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 09C

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

N91-24519 California Inst. of Tech., Pasadena.
A STUDY OF IMMISCIBLE LIQUIDS, LIQUID BEHAVIOR AT ZERO GRAVITY, AND DYNAMIC CONTACT LINES AND ANGLES Ph.D. Thesis
Gregory Todd Smedley 1990 281 p
Avail: Univ. Microfilms Order No. DA9031488

Three topics were investigated as part of preparation for a space based experiment. The intention of the experiment was to study the relationship between container geometry and interface geometry for a free liquid surface at zero gravity. A mathematical theory yields explicit geometrical criteria for the position of the free surface of a liquid at zero gravity in a cylindrical container of specified cross section. It is possible to find geometrical criteria that promise a particular liquid location. A unified graphical presentation of four geometries is given that can be used directly for the design of containments for liquids at zero gravity. As one application of these design curves, a container was built and tested in a series of two second drop-tower experiments. The identification of 121 transparent immiscible liquid pairs that have properties compatible with optical instrumentation based on laser-induced fluorescence is presented. Physical data such as specific gravity, index of refraction, viscosity, flash point, and toxicity were found in the literature. Compatibility with plexiglass (PMMA), contact angles of the internal meniscus on glass and PMMA, meniscus formation times, and clearing times were measured. A useful non-invasive for determining interfacial tensions is explained and used. The contact angle is a critical parameter in the consideration of liquid behavior at zero gravity; therefore, a technique based on laser light refraction was developed to objectively measure it. Dynamic contact line experiments were conducted at various velocities, both advancing and receding, using one of the 121 immiscible liquid pairs (nonane/formamide) in contact with glass. Dissert. Abstr.

N91-24520 Pennsylvania State Univ., University Park.
THE EFFECT OF COMPLIANT WALLS ON THREE-DIMENSIONAL PRIMARY AND SECONDARY INSTABILITIES IN BOUNDARY LAYER TRANSITION Ph.D. Thesis
Ronald Douglas Joslin 1990 317 p
Avail: Univ. Microfilms Order No. DA9104897

The use of passive devices to obtain drag and noise reductions of transition delays in boundary layers is highly desirable. One such device that shows promise for hydrodynamic applications is the compliant coating. In two-dimensional studies with a mechanical model representing the compliant wall, coatings were found that provided significant transition delays. The extended mechanical model is presented to allow for three-dimensional waves. The effect of compliant walls on three-dimensional secondary instabilities is also discussed. Dissert. Abstr.

N91-24521 Cornell Univ., Ithaca, NY.
TWO THEORETICAL STUDIES OF STABILITY OF SWIRLING FLOWS Ph.D. Thesis
Zhigang Yang 1990 168 p
Avail: Univ. Microfilms Order No. DA9106326

Two theoretical studies of swirling flow stabilities are considered. Linear stability for flow in a rotating pipe is calculated. Detailed results for the growth rate, real part of the complex frequency, and wave numbers of the most unstable models are presented in (Re,q) plane, the Reynolds number, and rotation rate plane. In the region of Re is much greater than 1, $q = O(1)$, the dominating unstable modes are given by wall mode perturbations characterized by large azimuthal wave numbers. An asymptotic

method is used to study these wall modes. The weakly nonlinear evolution of wave systems is studied neat the marginal stability curve. The flow undergoes a supercritical bifurcation when crossing the marginal stability curve. The evolution of the envelope of the wave system is described by a complex Ginzburg-Landau equation. The Ginzburg-Landau equation admits solution of the traveling wave form, which represents modulations to the traveling waves given by the linear theory. In certain windows of the wave number, the modulated traveling waves are linearly unstable through a side-band mechanism. The Hall-Stewartson leading-edge vortex is demonstrated to be linearly unstable to viscous perturbations of the center-mode type. Center modes are found to occur in two regions of Reynolds number-wavelength space. The appropriate center mode equations are established, and the two sets are found to be identical. The single system of equations, which depends on the azimuthal wavenumber and a distance parameter, sigma, is solved numerically. Highly unstable modes with the growth rate proportional to Re(exp 1.4) are found for large positive sigma, and the results are shown to be in good agreement with proposed asymptotic expansions. The length scale of the unstable perturbation goes to zero as Re goes to infinity. Questions concerning numerically capturing the center mode solutions are also addressed. Dissert. Abstr.

N91-24522 Rhode Island Univ., Kingston.
ACOUSTIC HARMONIC AND TRANSIENT RESPONSE OF FLUID-LOADED SHELLS OF REVOLUTION Ph.D. Thesis
Huo-Wang Chen 1990 253 p
Avail: Univ. Microfilms Order No. DA9106508

The harmonic and transient response of fluid loaded shells of revolution is investigated. A general approach is presented to evaluate the vibratory response and pressure field of fluid loaded shells of revolutions which are excited by mechanical forces or acoustic incident waves. The approach is based on the use of an in vacuo modal expansion of the velocity of the shell and the mechanical or pressure excitation. The acoustic pressure on the vibrator is expressed as a modal expansion in which each modal pressure is a sum of modal velocities combined with self- and interaction modal radiation impulse responses. A new internal source density method is developed for calculating the acoustic self and interaction radiation impedance and impulse responses. Dissert. Abstr.

N91-24523 Exeter Univ. (England).
GOERTLER VORTEX INSTABILITIES OF INCOMPRESSIBLE AND COMPRESSIBLE BOUNDARY LAYERS Ph.D. Thesis
Philip David Wadey 1990 174 p
Avail: Univ. Microfilms Order No. BRDX91592

Some aspects of the Goertler vortex instability mechanism were studied using asymptotic and computational methods. The conditions under which Goertler vortices may form in a wall jet velocity field are considered for vortices of high wavenumber. In the linear stability regime, it is shown that this instability can be seen on walls of both concave and convex curvature. The linear stability of Goertler vortices in a compressible boundary layer is considered for vortices of 0(1) wavenumber. The equations of motion for the vortex disturbance are reduced to a system of three coupled partial differential equations. These are solved on a finite difference grid by a marching process to determine the downstream variation of a function representing the energy of the disturbance. The nonlinear development of Goertler vortices in a compressible boundary layer is considered for vortices of asymptotically large wavenumber. It is shown how the same basic structure which occurs in incompressible flow exists. A discussion about some experimental work performed in order to visualize Goertler vortices in a wall jet velocity field on a concave plate is presented. Dissert. Abstr.

N91-24524 State Univ. of New York, Stony Brook.
THEORETICAL AND NUMERICAL INVESTIGATIONS OF SCALAR FIELDS IN ISOTROPIC TURBULENCE Ph.D. Thesis
Feng Gao 1990 172 p
Avail: Univ. Microfilms Order No. DA9106813

The behavior of turbulent scalar fields is investigated both theoretically and numerically. A relation is derived between this pdf and the pdf of a scalar and its x-derivative. The direct numerical simulation (DNS) technique is employed to calculate the expansion coefficients of scalar fields advected by isotropic stationary turbulence. The pseudo-spectral method is discussed and the DNS code is modified to accommodate reacting scalars. Other aspects of the numerical methods, such as generation of the initial scalar fields, are also discussed. Results for single scalar and two scalar simple reactions are presented. Finally, a parallel/consecutive reaction scheme is simulated and the numerical data are used to test a closure model. Dissert. Abstr.

N91-24525*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCES IN MODELING THE PRESSURE CORRELATION TERMS IN THE SECOND MOMENT EQUATIONS
Tsan-Hsing Shih, Aamir Shabbir, and John L. Lumley (Cornell Univ., Ithaca, NY.) Jun. 1991 37 p
(Grants NAG1-954; NASA Order C-99066-6; AF-AFOSR-0226-89; NSF DMS-88-14553; NSF MSM-86-11164)
(NASA-TM-104413; ICOMP-91-09; E-6241; NAS 1.15:104413; CMOTT-91-03) Avail: NTIS HC/MF A03 CSCL 20D

In developing turbulence models, various model constraints were proposed in an attempt to make the model equations more general (or universal). The most recent of these are the realizability principle, the linearity principle, the rapid distortion theory, and the material indifference principle. Several issues are discussed concerning these principles and special attention is payed to the realizability principle. Realizability (defined as the requirement of non-negative energy and Schwarz' inequality between any fluctuating quantities) is the basic physical and mathematical principle that any modeled equation should obey. Hence, it is the most universal, important and also the minimal requirement for a model equation to prevent it from producing unphysical results. The principle of realizability is described in detail, the realizability conditions are derived for various turbulence models, and the model forms are proposed for the pressure correlation terms in the second moment equations. Detailed comparisons of various turbulence models with experiments and direct numerical simulations are presented. As a special case of turbulence, the two dimensional two-component turbulence modeling is also discussed. Author

N91-24526# Aeronautical Research Inst. of Sweden, Stockholm. Aeodynamics Dept.
ON MISSING BOUNDARY CONDITIONS WITH UNSTEADY INCOMPRESSIBLE NAVIER-STOKES FLOWS
Friedrich Karl Hebeker (IBM Deutschland G.m.b.H., Heidelberg, Germany, F.R.) and Peter Wilde Dec. 1990 19 p Sponsored in part by Swedish National Board for Technical Development
(FFA-TN-1990-45; ETN-91-99106) Avail: NTIS HC/MF A03

An unsteady viscous flow problem where good boundary conditions are available on only part of the boundary is investigated. This problem appears when the flow phenomena of interest are concentrated in a part of the flow region and, for reasons of computational economy, are numerically computed in this subregion only. Assuming that outside of the subregion the flow is not subjected to acceleration forces, an (abstract) combined finite element/boundary element scheme to approximately compute the flow is developed. This scheme leads to a proof of existence of a weak solution of the corresponding Navier-Stokes problem as well. ESA

N91-24527*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PARAMAGNETIC PROPELLANT ORIENTATION
R. C. Hendricks 1991 9 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-26 Jun. 1991; sponsoned by AIAA, SAE, and ASME
(NASA-TM-104390; E-6165; NAS 1.15:104390; AIAA-91-2325)
Avail: NTIS HC/MF A02 CSCL 20D

Deep space or low earth orbital propellant tanks require a fluid orientation system prior to engine firing or transfer. Some

propellants such as cryogenic hydrogen, oxygen, and air are paramagnetic and respond to electromagnetic fields. A simple magnetic scheme is described for propellant orientation and a video tape presentation is provided that demonstrates some effects of magnetic fields on liquid air and oxygen in a low gravity simulator using the Leidenfrost phenomenon. When these Leidenfrost drops intersect the field lines, their flight paths are altered, some directly into the poles, some to the edges, and others move out of the field. Author

N91-24528*# Sverdrup Technology, Inc., Brook Park, OH.
TIME-DERIVATIVE PRECONDITIONING FOR VISCOUS FLOWS Final Report
Yunho Choi and Charles L. Merkle (Pennsylvania State Univ., University Park.) Cleveland, OH NASA Jun. 1991 13 p
(Contract NAS3-25266)
(NASA-CR-187139; E-6269; NAS 1.26:187139; AIAA-91-1652)
Avail: NTIS HC/MF A03 CSCL 20D

A time-derivative preconditioning algorithm that is effective over a wide range of flow conditions from inviscid to very diffusive flows and from low speed to supersonic flows was developed. This algorithm uses a viscous set of primary dependent variables to introduce well-conditioned eigenvalues and to avoid having a nonphysical time reversal for viscous flow. The resulting algorithm also provides a mechanism for controlling the inviscid and viscous time step parameters to be of order one for very diffusive flows, thereby ensuring rapid convergence at very viscous flows as well as for inviscid flows. Convergence capabilities are demonstrated through computation of a wide variety of problems. Author

N91-24529# Ballistic Research Labs., Aberdeen Proving Ground, MD.
MASS TRANSFER OF DECAYING PRODUCTS IN VORTEX PIPE FLOW WITH GRAVITY EFFECT Final Report, 1-31 Oct. 1990
Thomas A. Korjack Feb. 1991 21 p
(AD-A232875; BRL-TR-3208) Avail: NTIS HC/MF A03 CSCL 20/4

The problem of steady-state diffusion of the decaying products resulting from the disintegration of an inert gas in a forced and diminishing vortex through a vertical cylindrical tube section under symmetrical gravitational influences is presented. The disintegration products of the gas diffuse radically to the walls where they are completely annihilated. The flow properties of the fluid phase are determined by solving the complete Navier Stokes equations, and the respective solutions for the concentration distributions are obtained. The nondimensional bulk concentration values for the respective gravity and Peclet parameterization are also presented. These values are of importance in the determination of the diffusion coefficients of the disintegration products as well as the estimation of the losses of particles in connecting tubes (stationary/rotating) which arise from diffusion. The results of these calculations indicate that increasing the inertial forces over the diffusive forces causes an increase in particle penetration; also, increasing the gravity field at a fixed Peclet number increases the penetration or inhibits wall deposition. Similarly, increasing the gravity field at a fixed Peclet number and increasing the Peclet number for fixed gravity field diminished the concentration profile. GRA

N91-24530# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
VISCOUS DESIGN AND ANALYSIS METHODS FOR TRANSONIC COMPRESSOR BLADING Final Technical Report, 15 May 1989 - 30 Sep. 1990
Mark Drela 13 Feb. 1991 167 p
(Grant AF-AFOSR-0373-89; AF Proj. 2307)
(AD-A232902; AFOSR-91-0184TR) Avail: NTIS HC/MF A08 CSCL 20/4

A viscous/inviscid computational method for the design and analysis of quasi-3D cascades has been developed. The specific application targeted is supersonic compressor blading with splitter blades, although the method is applicable to any type of cascade. The method is an extension of the ISES viscous/inviscid methodology. A streamline-based inviscid Euler formulation is fully coupled to an integral boundary layer formulation to describe the overall viscous flowfield. Rotation and streamtube contraction effects have been incorporated. The method is accurate with regards to loading and loss, and is substantially faster than equivalent Navier-Stokes solvers. Inverse design and optimization capabilities are also implemented giving an effective design/analysis system. Existing supersonic splittered cascades were investigated to determine what characteristics are desirable or undesirable in this type of blading. Sensitivity studies indicate that tangential splitter position and splitter loading details have little influence on performance. Substantial improvements are possible if the splitter is moved aft into a tandem-blade arrangement with the main blade. Comparisons between computational results and measured data strongly suggest that traditional supersonic cascade tests involve substantial three-dimensional effects which are not correctable by measured streamtube contraction. GRA

N91-24531# Worcester Polytechnic Inst., MA.
THE EFFECT OF SYMMETRY ON THE HYDRODYNAMIC STABILITY OF AND BIFURCATION FROM PLANAR SHEAR FLOWS Final Report, 1 Sep. 1988 - 31 Dec. 1989
Thomas J. Bridges Dec. 1990 71 p
(Grant AF-AFOSR-0196-88)
(AD-A232916; AFOSR-91-0167TR) Avail: NTIS HC/MF A04 CSCL 20/4

A new approach to boundary layer transition has been developed based on the use of dynamical systems theory in a spatial setting. The results extend the classic theory of spatial stability into the nonlinear regime and a theory for spatial Hopf bifurcation, spatial Floquet theory, wavelength doubling and spatially quasi-periodic states has been developed and applied to the boundary layer problem. The demonstration of the prevalence of spatially quasi-periodic states (in the Blasius boundary layer) is important for applications because it provides the first mathematically consistent theory for the appearance of spatially quasi-periodic states in shear flows which have been observed in experiments. Exact symmetries in the Navier-Stokes equations and normal form symmetries play a basic role in the theory and require use of equivariant dynamical systems theory. Scenarios for the transition to turbulence are easily postulated in the spatial (convective) framework and a conjecture on the transition to 'convective' turbulence through wavelength doubling is introduced. GRA

N91-24532# Naval Postgraduate School, Monterey, CA.
INTERACTION OF A VORTEX PAIR WITH A FREE SURFACE: MEASUREMENTS AND COMPUTATIONS M.S. Thesis
Peter B. Suthon Jun. 1990 135 p
(AD-A233045) Avail: NTIS HC/MF A07 CSCL 20/4

An investigation of the interaction of two-counter-rotating vortices with a free surface has been undertaken. Experiments were carried out in two water basins and in a long towing tank through the use of measurements, flow visualization, and an infrared camera. The results have shown that all types of vortex pairs over a wide range of Froude Numbers give rise to three-dimensional surface disturbances, known as scars and striations. The striations are a consequence of the short wavelength instability inherent to the vortex pair itself. The scars are transported outward by the vortex pair and are comprised of a constellation of coherent vortical structures (whirls). The experiments have provided sufficient understanding of the physics of the phenomenon and led to the development of a numerical model based on vortex dynamics. This model proved to be capable of explaining the physical processes involved in the evolution of the three-dimensional footprints of the vortex pair. GRA

N91-24533# California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.
SIMULATION OF THE FLOW PAST AN IMPULSIVELY STARTED CYLINDER USING A DISCRETE VORTEX METHOD Final Report
Francois Pepin 11 May 1990 152 p

(Grant AF-AFOSR-0155-88; AF Proj. 2308)
(AD-A233066; AFOSR-91-0165TR) Avail: NTIS HC/MF A08
CSCL 20/4

Vortex methods are a powerful method for simulating incompressible flows at high Reynolds number. This work extends the basic method to include viscous effects in the presence of solid boundaries. The combination of a fully viscous vortex method with a fast parallel algorithm is used to simulate the flow past an impulsively started cylinder. Experiments have shown that this flow is characterized by the presence of secondary eddies within the main recirculating region. The numerical simulations successfully reproduced these secondary structures over a wide range of Reynolds number (Re = 550 to 9500). It was observed that the secondary phenomenon can lead to a major flow reorganization by drastically altering the transport of vorticity. At Re = 550, the vortex sheet smoothly rolls up into the primary vortex. For Re = 3000 and 9500, however, secondary eddies interfere with that process and the flux of vorticity is redirected toward the cylinder where it accumulates into a new vortical structure. The impulsive start is followed by a 1/(square root of t) singularity in the drag coefficients. The numerical simulations captured this behavior and the computed drag history for short times is in close agreement with the one predicted by a matched asymptotics analysis. GRA

N91-24534# Army Cold Regions Research and Engineering Lab., Hanover, NH.
NATURAL CONVECTION HEAT TRANSFER IN WATER NEAR ITS DENSITY MAXIMUM
Yin-Chao Yen Dec. 1990 103 p
(DA Proj. 4A1-61102-AT-24)
(AD-A233106; CRREL-MONOGRAPH-90-4) Avail: NTIS HC/MF A06 CSCL 20/4

This monograph reviews and summarizes to date the experimental and analytical results on the effect of water density near its maximum convection, transient flow and temperature structure characteristics: (1) in a vertical enclosure; (2) in a vertical annulus; (3) between horizontal concentric cylinders; (4) in a square enclosure; (5) in a rectangular enclosure; (6) in a horizontal layer; (7) in a circular confined melt layer; and (8) in bulk water during melting. In a layer of water containing a maximum density temperature of 4 C, the onset of convection (the critical number) is found not to be a constant value as in the classical normal fluid but one that varies with the imposed thermal and hydrodynamic boundaries. In horizontal layers, a nearly constant temperature zone forms and continuously expands between the warm and cold boundaries. A minimum heat transfer exists in most of the geometries studied and, in most cases, can be expressed in terms of a density distribution parameter. The effect of this parameter on a cells formation, disappearance and transient structure is discussed, and the effect of split boundary flow on heat transfer is presented. GRA

N91-24535# McDonnell Aircraft Co., Saint Louis, MO.
SECOND-ORDER FAR FIELD COMPUTATIONAL BOUNDARY CONDITIONS FOR INVISCID DUCT FLOW PROBLEMS Final Report, Sep. 1985 - Sep. 1988
August Verhoff Mar. 1990 51 p
(Contract N622271-85-M-0462)
(AD-A233143; NPS67-90-001CR) Avail: NTIS HC/MF A04
CSCL 20/4

Highly accurate far field computational boundary conditions for inviscid, 2-D isentropic duct flow problems are developed from analytic solutions of the linearized, second-order Euler equations. The Euler equations are linearized about a constant pressure, rectilinear flow condition. The boundary procedure can be used with any numerical Euler solution method and allows computational boundaries to be located extremely close to the nonlinear region of interest. Numerical results are presented which show that the boundary conditions and far field analytic solutions provide a smooth transition across a computational boundary to the true far field conditions at infinity. The cost of upgrading first-order boundary conditions to second-order is slight. GRA

N91-24536# Applied Research Lab., State College, PA.
THE EFFECT OF COMPLIANT WALLS ON THREE-DIMENSIONAL PRIMARY AND SECONDARY INSTABILITIES IN BOUNDARY LAYER TRANSITION
R. D. Joslin Apr. 1991 315 p
(Contract N00039-88-C-0051)
(AD-A233150; ARL/PSU/TR-91-003) Avail: NTIS HC/MF A14
CSCL 20/4

The use of passive devices to obtain drag and noise reduction or transition delays in boundary layers is highly desirable. One such device that shows promise for hydrodynamic applications is the compliant coating. The present study extends the mechanical model to allow for three-dimensional waves. This study also looks at the effect of compliant walls on three-dimensional secondary instabilities. For the primary and secondary instability analysis, spectral and shooting approximations are used to obtain solutions of the governing equations and boundary conditions. The spectral approximation consists of local and global methods of solution while the shooting approach is local. The global method is used to determine the discrete spectrum of eigenvalue without any initial guess. The local method requires a sufficiently accurate initial guess to converge to the eigenvalue. Eigenvectors may be obtained with either local approach. For the initial stage of this analysis, two and three dimensional primary instabilities propagate over compliant coatings. Results over the compliant walls are compared with the rigid wall case. Three-dimensional instabilities are found to dominate transition over the compliant walls considered. However, transition delays are still obtained and compared with transition delay predictions for rigid walls. The angles of wave propagation are plotted with Reynolds number and frequency. Low frequency waves are found to be highly three-dimensional. GRA

N91-24537# Wisconsin Univ., Madison. Center for Mathematical Sciences.
NUMERICAL SIMULATION OF HOLE PRESSURE FOR A JOHNSON-SEGALMAN FLUID Summary Report
M. Yao and D. S. Malkus Apr. 1990 27 p
(AD-A233164; CMS-TSR-90-23) Avail: NTIS HC/MF A03
CSCL 20/4

The hole pressure problem is studied for plane, steady, creeping shear flows of a Johnson Segalman model. To correctly apply the theory of Higashitani, Pritchard, Baird and Lodge (HPBL), a modified hole pressure relation (MHPR) is begun and the hole pressure measurement is simulated by FEM and multi-mesh extrapolation techniques. The path integrals of MHPR and HPBL are evaluated and a full instrument simulation is conducted. An encouraging agreement between the simulated hole pressure and the analytical prediction is found, within the computationally-accessible range of De less than or = 1, which supports the postulates about the possible error cancellation in MHPR and the validity of HPBL for J-S fluid. This numerical investigation also corroborates the evidence, given by the independent experiment and other numerical work, that N sub 1 can be predicted via the HPBL equations to a sufficient approximation to be of practical use. GRA

N91-24538# University of Southern California, Los Angeles. Dept. of Petroleum Engineering.
LONG WAVES IN PARALLEL FLOW IN HELE-SHAW CELLS
M. Zeybek and Y. C. Yortsos Apr. 1991 33 p
(Contract DE-FG22-90BC-14600)
(DE91-002232; DOE/BC-14600/7) Avail: NTIS HC/MF A03

During the past several years the flow of immiscible flow in Hele-Shaw cells and porous media has been investigated extensively. Of particular interest to most studies has been frontal displacement, specifically viscous fingering instabilities and finger growth. The practical ramifications regarding oil recovery, as well as many other industrial processes in porous media, have served as the primary driving force for most of these investigations. By contrast, little attention has been paid to the motion of lateral fluid interface, which are parallel to the main flow direction. Parallel flow is an often encountered, although much overlooked regime. The evolution of fluid interfaces in parallel flow in Hele-Shaw cells is studied both theoretically and experimentally in the large capillary

number limit. It is shown that such interfaces support wave motion, the amplitude of which for long waves is governed by the KdV equation. Experiments are conducted in a long Hele-Shaw cell that validate the theory in the symmetric case. DOE

N91-24539# Phillips Engineering Co., Saint Joseph, MI.
DEVELOPMENT OF A HIGH-EFFICIENCY, GAS-FIRED, ABSORPTION HEAT PUMP FOR RESIDENTIAL AND SMALL-COMMERCIAL APPLICATIONS
B. A. Phillips Sep. 1990 68 p Prepared for Oak Ridge National Lab., TN
(Contract DE-AC05-84OR-21400)
(DE91-010442; ORNL/Sub-86-24610/1) Avail: NTIS HC/MF A04

The purpose of the total project is to develop a gas fired absorption heat pump for residential and small commercial applications that will produce at least 1.6 Btu of heating and 0.7 Btu of cooling per Btu of heat content in the gas being burned. The primary technology advances that can be used to attain the new goals are higher efficiency cycles, increased flue efficiency, and better fluids. Flue efficiency technology is well developed, and fan assisted combustion systems with condensing heat exchangers can limit flue and insulation losses to the 10 pct range. If this 10 pct loss assumption is made, the resulting target cycle COPs are 1.78 in heating mode and 0.78 in cooling mode at the ARI rating conditions. The objective of Phase 1 was to analyze working fluids and absorption-cycle concepts that are capable of performing at the target COPs and are potentially competitive with existing space-conditioning products in cost, operating life, and reliability. Six advanced cycles were evaluated with ammonia/water as the fluid pair. Then additional analysis was performed with other fluid pairs to determine whether cycle ranking would change depending on which fluid was used. It was concluded that the preferred cycle/fluid was the generator-absorber heat exchange (GAX) cycle using ammonia/water as the fluid pair. A cost estimate made by an independent manufacturing engineering firm for a residential heat pump based on the cycle/fluid combination determined that the GAX heat pump could be cost competitive with existing products. DOE

N91-24540# International Centre for Theoretical Physics, Trieste (Italy).
THE WITTEN-JONES INVARIANT FOR FLOWS ON A 3-DIMENSIONAL MANIFOLD
A. Verjovsky and R. F. VilaFreyer Sep. 1990 13 p
(DE91-617576; IC-90/291) Avail: NTIS HC/MF A03

The Witten-Jones functional for knots is generalized for smooth flows on 3-dimensional manifolds. Explicit computations for the abelian case are given. DOE

N91-24541*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NAVIER-STOKES SIMULATION OF THE SUPERSONIC COMBUSTION FLOWFIELD IN A RAM ACCELERATOR
Shaye Yungster 1991 18 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers Original contains color illustrations
(NASA Order C-99066-G)
(NASA-TM-104439; ICOMP-91-10; E-6278; NAS 1.15:104439; AIAA-91-1916) Avail: NTIS HC/MF A03; 6 functional color pages CSCL 20D

A computational study of the ram accelerator, a ramjet-in-tube device for accelerating projectiles to ultrahigh velocities, is presented. The analysis is performed using a fully implicit TVD scheme that efficiently solves the Reynolds-averaged Navier-Stokes equations and the species continuity equations associated with a finite rate combustion model. Previous analyses of this concept were based on inviscid assumptions. The present results indicate that viscous effects are of primary importance; in all the cases studied, shock-induced combustion always started in the boundary layer. The effects of Mach number, mixture composition, pressure, and turbulence are investigated for various configurations. Two types of combustion processes, one stable and the other unstable, were observed depending on the inflow conditions. In the unstable case, a detonation wave is formed, which propagates upstream and unstarts the ram accelerator. In the stable case, a solution that converges to steady-state is obtained, in which the combustion wave remains stationary with respect to the ram accelerator projectile. The possibility of stabilizing the detonation wave by means of a backward facing step is also investigated. In addition to these studies, two numerical techniques were tested. These two techniques are vector extrapolation to accelerate convergence, and a diagonal formulation that eliminates the expense of inverting large block matrices that arise in chemically reacting flows. Author

N91-24542*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SATURATION POINT MODEL FOR THE FORMATION OF METAL NITRATE IN NITROGEN TETROXIDE OXIDIZER
Paul R. Torrance Washington May 1991 19 p
(NASA-TP-3107; S-630; NAS 1.60:3107) Avail: NTIS HC/MF A03 CSCL 20D

A model was developed for the formation of metal nitrate in nitrogen tetroxide (N_2O_4). The basis of this model is the saturation point of metal nitrate in N_2O_4. This basis is chosen mainly because of the White Sands Test Facility's metal nitrate in N_2O_4 experience. Means of reaching the saturation point are examined, and a relationship is made for the reaction/formation rate and diffusion rate of metal nitrate in N_2O_4. Author

N91-24543*# California Univ., Davis. Dept. of MAME.
NAVIER-STOKES COMPUTATION OF COMPRESSIBLE TURBULENT FLOWS WITH A SECOND ORDER CLOSURE Progress Report, 1 May 1990 - 30 Apr. 1991
C. Dingus and W. Kollmann 30 Apr. 1991 38 p
(Contract NCC2-186)
(NASA-CR-188451; NAS 1.26:188451) Avail: NTIS HC/MF A03 CSCL 20D

The objective was the development of a complete second order closure for wall bounded flows, including all components of the dissipation rate tensor and a numerical solution procedure for the resulting system of equations. The main topics discussed are the closure of the pressure correlations and the viscous destruction terms in the dissipation rate equations and the numerical solution scheme based on a block-tridiagonal solver for the nine equations required for the prediction of plane or axisymmetric flows.
Author

N91-24544*# Cleveland State Univ., OH. Dept. of Mechanical Engineering.
NAVIER-STOKES ANALYSIS OF TURBOMACHINERY BLADE EXTERNAL HEAT TRANSFER Final Technical Report
Rama S. R. Gorla 1991 35 p
(Grant NAG3-548)
(NASA-CR-188454; NAS 1.26:188454) Avail: NTIS HC/MF A03 CSCL 20D

The two-dimensional, compressible, thin-layer Navier-Stokes and energy equations were solved numerically to obtain heat transfer rates on turbomachinery blades. The Baldwin-Lomax algebraic model and the q-omega low Reynolds number two-equation model were used for modeling of turbulence. For the numerical solution of the governing equations a four-stage Runge-Kutta solver was employed. The turbulence model equations were solved using an implicit scheme. Numerical solutions are presented for two-dimensional flow within two vane cascades. The heat transfer results and the pressure distributions were compared with published experimental data. The agreement between the numerical calculations and the experimental values were found to be generally favorable. The position of transition from laminar to turbulent flow was also predicted accurately. Author

N91-24545*# Wisconsin Univ., Madison. Applied Superconductivity Center.
CHARACTERIZING He 2 FLOW THROUGH POROUS MATERIALS USING COUNTERFLOW DATA Final Technical Report, 15 Jan. - 31 Dec. 1990
Steven W. VanSciver and J. R. Maddocks 1991 16 p Presented at the Cryogenic Engineering Conference, Huntsville, AL, 1991
(Grant NAG5-1031)
(NASA-CR-188453; NAS 1.26:188453) Avail: NTIS HC/MF A03 CSCL 20D

Proposed space applications, such as the cooling of infrared and x ray telescopes, have generated substantial interest in the behavior of He(2) flowing in porous materials. For design purposes, classical porous media correlations and room temperature data are often used to obtain order of magnitude estimates of expected pressure drops, while the attendant temperature differences are either ignored or estimated using smooth tube correlations. A more accurate alternative to this procedure is suggested by an empirical extension of the two fluid models. It is shown that four empirical parameters are necessary to describe the pressure and temperature differences induced by He(2) flow through a porous sample. The three parameters required to determine pressure differences are measured in counterflow and found to compare favorably with those for isothermal flow. The fourth parameter, the Gorter-Mellink constant, differs substantially from smooth tube values. It is concluded that parameter values determined from counterflow can be used to predict pressure and temperature differences in a variety of flows to an accuracy of about + or - 20 percent. Author

N91-24546*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
MODELING THE PRESSURE-DILATATION CORRELATION Final Report
S. Sarkar May 1991 21 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187566; NAS 1.26:187566; ICASE-91-42) Avail: NTIS HC/MF A03 CSCL 20D

It is generally accepted that pressure dilatation, which is an additional compressibility term in turbulence transport equations, may be important for high speed flows. Recent direct simulations of homogeneous shear turbulence have given concrete evidence that the pressure dilatation is important insofar that it contributes to the reduced growth of turbulent kinetic energy due to compressibility effects. The problem of modeling pressure dilatation is addressed. A component of the pressure dilatation is isolated which exhibits temporal oscillations and, using direct numerical simulations of homogeneous shear turbulence and isotropic turbulence, show that it has a negligible contribution to the evolution of turbulent kinetic energy. Then, an analysis for the case of homogeneous turbulence is performed to obtain a model for the nonoscillatory pressure dilatation. This model algebraically relates the pressure dilatation to quantities traditionally obtained in incompressible turbulence closures. The model is validated by direct comparison with the pressure dilatation data obtained from the simulations. Author

N91-24547*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GROUND TESTING ON THE NONVENTED FILL METHOD OF ORBITAL PROPELLANT TRANSFER: RESULTS OF INITIAL TEST SERIES
David J. Chato 1991 32 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104444; E-6284; NAS 1.15:104444; AIAA-91-2326)
Avail: NTIS HC/MF A03 CSCL 20D

The results are presented of a series of no-vent fill experiments conducted on a 175 cu ft flightweight hydrogen tank. The experiments consisted of the nonvented fill of the tankage with liquid hydrogen using two different inlet systems (top spray, and bottom spray) at different tank initial conditions and inflow rates. Nine tests were completed of which six filled in excess of 94 percent. The experiments demonstrated a consistent and repeatable ability to fill the tank in excess of 94 percent using the nonvented fill technique. Ninety-four percent was established as the high level cutoff due to requirements for some tank ullage to prevent rapid tank pressure rise which occurs in a tank filled entirely with liquid. The best fill was terminated at 94 percent full with a tank internal pressure less than 26 psia. Although the baseline initial tank wall temperature criteria was that all portions of the tank wall be less than 40 R, fills were achieved with initial wall temperatures as high as 227 R. Author

N91-24548*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A NUMERICAL STUDY OF THE DIRECT CONTACT CONDENSATION ON A HORIZONTAL SURFACE
M. M. Hasan and C. S. Lin (Analex Corp., Fairview Park, OH.) 1991 11 p Presented at the 26th Thermophysics Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(Contract NAS3-25776)
(NASA-TM-104432; E-6270; NAS 1.15:104432; AIAA-91-1307)
Avail: NTIS HC/MF A03 CSCL 20D

The results of a numerical study of the direct contact condensation on a slowly moving horizontal liquid surface are presented. The geometrical configuration and the input conditions used to obtain numerical solutions are representative to those of experiments of Celata et al. The effects of Prandtl number (Pr), inflow Reynolds number, and Richardson number on the condensation rate are investigated. Numerical predictions of condensation rate for laminar flow are in good agreement with experimental data. The effect of buoyancy on the condensation rate is characterized by Richardson number. A correlation based on the numerical solutions is developed to predict the average condensation Nusselt number in terms of Richardson number, Peclet number, and inflow Reynolds number. Author

N91-24549*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SCALING ANALYSIS APPLIED TO THE NORVEX CODE DEVELOPMENT AND THERMAL ENERGY FLIGHT EXPERIMENT
J. Raymond Lee Skarda, David Namkoong, and Douglas Darling 1991 13 p Presented at the 26th Thermophysics Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(NASA-TM-104462; E-6303; NAS 1.15:104462; AIAA-91-1420)
Avail: NTIS HC/MF A03 CSCL 20D

A scaling analysis is used to study the dominant flow processes that occur in molten phase change material (PCM) under 1 g and microgravity conditions. Results of the scaling analysis are applied to the development of the NORVEX (NASA Oak Ridge Void Experiment) computer program and the preparation of the Thermal Energy Storage (TES) flight experiment. The NORVEX computer program which is being developed to predict melting and freezing with void formation in a 1 g or microgravity environment of the PCM is described. NORVEX predictions are compared with the scaling and similarity results. The approach to be used to validate NORVEX with TES flight data is also discussed. Similarity and scaling show that the inertial terms must be included as part of the momentum equation in either the 1 g or microgravity environment (a creeping flow assumption is invalid). A 10(exp -4) environment was found to be a suitable microgravity environment for the proposed PCM. Author

N91-24550*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPARISON OF SMAC, PISO, AND ITERATIVE TIME-ADVANCING SCHEMES FOR UNSTEADY FLOWS
Sang-Wook Kim (Texas Univ., Arlington.) and Thomas J. Benson Jun. 1991 43 p
(NASA-TM-104406; E-6232; NAS 1.15:104406) Avail: NTIS HC/MF A03 CSCL 20D

Calculations of unsteady flows using a simplified marker and cell (SMAC), a pressure implicit splitting of operators (PSIO), and

an iterative time advancing scheme (ITA) are presented. A partial differential equation for incremental pressure is used in each time advancing scheme. Example flows considered are a polar cavity flow starting from rest and self-sustained oscillating flows over a circular and a square cylinder. For a large time step size, the SMAC and ITA are more strongly convergent and yield more accurate results than PSIO. The SMAC is the most efficient computationally. For a small time step size, the three time advancing schemes yield equally accurate Strouhal numbers. The capability of each time advancing scheme to accurately resolve unsteady flows is attributed to the use of new pressure correction algorithm that can strongly enforce the conservation of mass. The numerical results show that the low frequency of the vortex shedding is caused by the growth time of each vortex shed into the wake region. Author

N91-24551*# Pratt and Whitney Aircraft, West Palm Beach, FL. Commercial Engine Business.

COOLANT SIDE HEAT TRANSFER WITH ROTATION. TASK 3 REPORT: APPLICATION OF COMPUTATIONAL FLUID DYNAMICS

F. C. Kopper, G. J. Sturgess, and P. Datta Jan. 1989 91 p
(Contract NAS3-23691)
(NASA-CR-182109; NAS 1.26:182109; PWA-5930-29) Avail: NTIS HC/MF A05 CSCL 20D

An experimental and analytical program was conducted to investigate heat transfer and pressure losses in rotating multipass passages with configurations and dimensions typical of modern turbine blades. The objective of this program is the development and verification of improved analysis methods that will form the basis for a design system that will produce turbine components with improved durability. As part of this overall program, a technique is developed for computational fluid dynamics. The specific objectives were to: select a baseline CFD computer code, assess the limitations of the baseline code, modify the baseline code for rotational effects, verify the modified code against benchmark experiments in the literature, and to identify shortcomings in the code as revealed by the verification. The Pratt and Whitney 3D-TEACH CFD code was selected as the vehicle for this program. The code was modified to account for rotating internal flows, and these modifications were evaluated for flow characteristics of those expected in the application. Results can make a useful contribution to blade internal cooling. Author

N91-24552*# Pratt and Whitney Aircraft, West Palm Beach, FL. Commercial Engine Business.

COOLANT SIDE HEAT TRANSFER WITH ROTATION: USER MANUAL FOR 3D-TEACH WITH ROTATION

S. A. Syed and R. H. James Feb. 1989 104 p
(Contract NAS3-23691)
(NASA-CR-180886; NAS 1.26:180886; PWA-5930-33) Avail: NTIS HC/MF A06 CSCL 20D

This program solves the governing transport equations in Reynolds average form for the flow of a 3-D, steady state, viscous, heat conducting, multiple species, single phase, Newtonian fluid with combustion. The governing partial differential equations are solved in physical variables in either a Cartesian or cylindrical coordinate system. The effects of rotation on the momentum and enthalpy calculations modeled in Cartesian coordinates are examined. The flow of the fluid should be confined and subsonic with a maximum Mach number no larger than 0.5. This manual describes the operating procedures and input details for executing a 3D-TEACH computation. Author

N91-24553*# Gedeon Associates, Athens, OH.

MANIFEST: A COMPUTER PROGRAM FOR 2-D FLOW MODELING IN STIRLING MACHINES Final Report

David Gedeon May 1989 157 p
(Contract NAS3-25195)
(NASA-CR-182290; NAS 1.26:182290) Avail: NTIS HC/MF A08 CSCL 20D

A computer program named Manifest is discussed. Manifest is a program one might want to use to model the fluid dynamics in the manifolds commonly found between the heat exchangers and regenerators of Stirling machines; but not just in the manifolds - in the regenerators as well. And in all sorts of other places too, such as: in heaters or coolers, or perhaps even in cylinder spaces. There are probably nonStirling uses for Manifest also. In broad strokes, Manifest will: (1) model oscillating internal compressible laminar fluid flow in a wide range of two-dimensional regions, either filled with porous materials or empty; (2) present a graphics-based user-friendly interface, allowing easy selection and modification of region shape and boundary condition specification; (3) run on a personal computer, or optionally (in the case of its number-crunching module) on a supercomputer; and (4) allow interactive examination of the solution output so the user can view vector plots of flow velocity, contour plots of pressure and temperature at various locations and tabulate energy-related integrals of interest. Author

N91-24554*# Ingersoll-Rand Co., Phillipsburg, NJ. Pump Group.

FLUCTUATING PRESSURES IN PUMP DIFFUSER AND COLLECTOR SCROLLS, PART 1 Final Report

Donald P. Sloteman Aug. 1989 460 p
(Contract NAS8-36223)
(NASA-CR-183781; NAS 1.26:183781) Avail: NTIS HC/MF A20 CSCL 20D

The cracking of scroll liners on the SSME High Pressure Fuel Turbo Pump (HPFTP) on hot gas engine test firings has prompted a study into the nature of pressure fluctuations in centrifugal pump states. The amplitudes of these fluctuations and where they originate in the pump stage are quantified. To accomplish this, a test program was conducted to map the pressure pulsation activity in a centrifugal pump stage. This stage is based on typical commercial (or generic) pump design practice and not the specialized design of the HPFTP. Measurements made in the various elements comprising the stage indicate that pulsation activity is dominated by synchronous related phenomena. Pulsation amplitudes measured in the scroll are low, on the order of 2 to 7 percent of the impeller exit tip speed velocity head. Significant non-sychronous pressure fluctuations occur at low flow, and while of interest to commercial pump designers, have little meaning to the HPFTP experience. Results obtained with the generic components do provide insights into possible pulsation related scroll failures on the HPFTP, and provide a basis for further study. Author

N91-24555*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

EFFECTS OF WING SWEEP ON IN-FLIGHT BOUNDARY-LAYER TRANSITION FOR A LAMINAR FLOW WING AT MACH NUMBERS FROM 0.60 TO 0.79

Bianca Trujillo Anderson and Robert R. Meyer, Jr. Jul. 1990 37 p Contains microfiche as supplement
(NASA-TM-101701; H-1565; NAS 1.15:101701) Avail: NTIS HC/MF A03 CSCL 20D

The variable sweep transition flight experiment (VSTFE) was conducted on an F-14A variable sweep wing fighter to examine the effect of wing sweep on natural boundary layer transition. Nearly full span upper surface gloves, extending to 60 percent chord, were attached to the F-14 aircraft's wings. The results are presented of the glove 2 flight tests. Glove 2 had an airfoil shape designed for natural laminar flow at a wing sweep of 20 deg. Sample pressure distributions and transition locations are presented with the complete results tabulated in a database. Data were obtained at wing sweeps of 15, 20, 25, 30, and 35 deg, at Mach numbers ranging from 0.60 to 0.79, and at altitudes ranging from 10,000 to 35,000 ft. Results show that a substantial amount of laminar flow was maintained at all the wing sweeps evaluated. The maximum transition Reynolds number obtained was 18.6 x 10(exp 6) at 15 deg of wing sweep, Mach 0.75, and at an altitude of 10,000 ft. Author

N91-24556*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
EFFECTS OF WING SWEEP ON BOUNDARY-LAYER TRANSITION FOR A SMOOTH F-14A WING AT MACH NUMBERS FROM 0.700 TO 0.825
Bianca Trujillo Anderson and Robert R. Meyer, Jr. May 1990 48 p Contains microfiche as supplement
(NASA-TM-101712; H-1531; NAS 1.15:101712) Avail: NTIS HC/MF A03 CSCL 20D

The results are discussed of the variable sweep transition flight experiment (VSTFE). The VSTFE was a natural laminar flow experiment flown on the swing wing F-14A aircraft. The main objective of the VSTFE was to determine the effects of wing sweep on boundary layer transition at conditions representative of transport aircraft. The experiment included the flight testing of two laminar flow wing gloves. Glove 1 was a cleanup of the existing F-14A wing. Glove 2, not discussed herein, was designed to provide favorable pressure distributions for natural laminar flow at Mach number (M) 0.700. The transition locations presented for glove 1 were determined primarily by using hot film sensors. Boundary layer rake data was provided as a supplement. Transition data were obtained for leading edge wing sweeps of 15, 20, 25, 30, and 35 degs, with Mach numbers ranging from 0.700 to 0.825, and altitudes ranging from 10,000 to 35,000 ft. Results show that a substantial amount of laminar flow was maintained at all the wing sweeps evaluated. The maximum transition Reynolds number of 13.7 x 10(exp 6) was obtained for the condition of 15 deg of sweep, M = 0.800, and an altitude of 20,000 ft. Author

N91-24264# Aerospace Corp., El Segundo, CA.
A LINEARIZED THEORY FOR UNSTEADY FLOW ALONG VANE-FORMED FILLETS DRIVEN BY SURFACE TENSION
James J. Der *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 333-338 (For primary document see N91-24233 16-20)
(Contract F04701-88-C-0089)
Avail: NTIS HC/MF A20

N91-24336*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
A NEW FACILITY TO STUDY THREE DIMENSIONAL VISCOUS FLOW AND ROTOR-STATOR INTERACTION IN TURBINES Progress Report
B. Lakshminarayana, C. Camci, and I. Halliwell (General Electric Co., Cincinnati, OH.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 223-236 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20D

N91-24337*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN UNCONDITIONALLY STABLE RUNGE-KUTTA METHOD FOR UNSTEADY ROTOR-STATOR INTERACTION
Rodrick V. Chima and Philip C. E. Jorgenson *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 237-246 Previously announced in IAA as A89-25180 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20D

N91-24338*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AVERAGE-PASSAGE FLOW MODEL DEVELOPMENT
John J. Adamczyk, Mark L. Celestina, Tim A. Beach, Kevin Kirtley, and Mark Barnett (United Technologies Research Center, East Hartford, CT.) *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 247-251 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20D

N91-25065*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
LONG DURATION EXPOSURE FACILITY (LDEF) LOW-TEMPERATURE HEAT PIPE EXPERIMENT PACKAGE (HEPP) Abstract Only
Roy McIntosh and Patrick J. Brennan (OAO Corp., Greenbelt, MD.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 99 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20D

N91-25066*# McDonnell-Douglas Electronics Co., Saint Louis, MO. Laser and Electronic Systems Div.
RESULTS FROM THE CASCADED VARIABLE CONDUCTANCE HEATPIPE EXPERIMENT ON LDEF Abstract Only
Michael G. Grote *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 100 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20D

N91-25067*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
LONG DURATION EXPOSURE FACILITY: TRANSVERSE FLAT PLATE HEAT PIPE Abstract Only
David Shular *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 101 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20D

35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

N91-24557*# Daedalus Enterprises, Inc., Ann Arbor, MI.
DEVELOPMENT OF A PORTABLE MULTISPECTRAL THERMAL INFRARED CAMERA Final Report
Frederick G. Osterwisch 30 May 1991 25 p
(Contract NAS7-1063)
(NASA-CR-188204; NAS 1.26:188204) Avail: NTIS HC/MF A03 CSCL 14E

The AA465 Thermal Infrared Camera (TIRC) System is a field portable multispectral thermal infrared camera operating over the 8.0 to 13.0 micron wavelength range. Its primary function is to acquire 2-D thermal infrared images of user selected scene. Thermal infrared energy emitted by the scene is collected, dispersed into ten 0.5 micron wide channels, and then measured and recorded by the AS465 System. This multispectral information is presented in real time on a color display to be used by the operator to identify spectral and spatial variations in the scene emissivity and/or irradiance. This fundamental instrument capability has a wide variety of commercial and research applications. While ideally suited for two man operation in the field, the AS465 System can be transported and operated effectively by a single user. Functionally, the instrument operates as if it were a single exposure camera. System measurement sensitivity requirements dictate relatively long (several minutes) instrument exposure times.

Author

N91-24558*# Intersonics, Inc., Northbrook, IL.
DEVELOPMENT OF HIGH TEMPERATURE CONTAINERLESS PROCESSING EQUIPMENT AND THE DESIGN AND EVALUATION OF ASSOCIATED SYSTEMS REQUIRED FOR MICROGRAVITY MATERIALS PROCESSING AND PROPERTY MEASUREMENTS Final Report
Charles A. Rey 28 Mar. 1991 209 p

(Contract NAS8-37592)
(NASA-CR-184158; NAS 1.26:184158) Avail: NTIS HC/MF A10 CSCL 14B

The development of high temperature containerless processing equipment and the design and evaluation of associated systems required for microgravity materials processing and property measurements are discussed. Efforts were directed towards the following task areas: design and development of a High Temperature Acoustic Levitator (HAL) for containerless processing and property measurements at high temperatures; testing of the HAL module to establish this technology for use as a positioning device for microgravity uses; construction and evaluation of a brassboard hot wall Acoustic Levitation Furnace; construction and evaluation of a noncontact temperature measurement (NCTM) system based on AGEMA thermal imaging camera; construction of a prototype Division of Amplitude Polarimetric Pyrometer for NCTM of levitated specimens; evaluation of and recommendations for techniques to control contamination in containerless materials processing chambers; and evaluation of techniques for heating specimens to high temperatures for containerless materials experimentation. Author

N91-24559# Virginia Polytechnic Inst. and State Univ., Blacksburg. Office of Sponsored Programs.
LOW-COST FIBER OPTIC WEIGH-IN-MOTION SENSOR Final Report
A. Safaai-Jazi, S. A. Ardekani, and M. Mehdikhani Nov. 1990 72 p
(PB91-152702; SHRP-IDEA/UFR-90-002) Avail: NTIS HC/MF A04 CSCL 14B

A design for a fiber optic weigh in motion (WIM) sensor is proposed. A prototype of the proposed sensor is designed, manufactured, and tested in the laboratory for different load frequency combinations using a material testing system (MTS) machine. Statistical analysis of data are performed to assess the response of the sensor under varying load frequencies for comparison. GRA

N91-24560# Brewer Science, Inc., Rolla, MO.
DEVELOPMENT OF MINIATURE TEMPERATURE SENSORS Final Report, 1 Jul. - 31 Dec. 1990
Mary G. Moss, Ryan E. Giedd, Kim Moeckli, and Terry Brewer 28 Jan. 1991 26 p
(Contract DAAL03-90-C-0012)
(AD-A232964; ARO-28081.1-EL-SBI) Avail: NTIS HC/MF A03 CSCL 14/2

Phase 1 work demonstrated temperature sensors formed from polyacrylonitrile and similar polymers which could be applied from solution onto a substrate, then subsequently ion implanted to have conductivity in the kiloohm to megaohm/square range. If desired, the films could be patterned before implantation to small geometries by lithographic procedures. The resulting films had a large, negative temperature coefficient of resistance, and the resistance-temperature response was reproducible and retraceable within experimental error over multiple cycles. The films were extremely durable and solvent-resistant. A quasi-one dimensional hopping mechanism for conduction was indicated from the conductivity versus temperature and conductivity versus pressure measurements. GRA

N91-24561# Sparta, Inc., Lexington, MA.
MULTIPLE APERTURE IMAGER COMPONENT DEVELOPMENT Final Report, 26 Jul. 1989 - 30 Sep. 1990
David E. Lees and Philip D. Henshaw 4 Mar. 1991 50 p
(Contract N00014-88-C-0518)
(AD-A233413; LTR91-006) Avail: NTIS HC/MF A03 CSCL 17/5

This final report presents results of an experimental and analytical effort to develop multiple aperture imagers built from unphased, direct-detection subapertures. An object was imaged using wave length shift instead of object motion to create multiple speckle pattern realizations. An analysis of subaperture geometry effects of autocorrelation estimate was performed. Experimental measurements of detector modulator transfer function were made. Finally, a new algorithm to reconstruct imagery with improved signal-to-noise ratio was developed. GRA

N91-24562# Humbug Mountain Research Labs., Duarte, CA.
PARTICLE DENSITOMETER BASED ON THE ACOUSTICAL RESONANCE MEASUREMENT
A. A. Vetter 2 Apr. 1991 14 p
(Contract DE-FG01-89CE-15453)
(DE91-009979; HMRL-R-73-6) Avail: NTIS HC/MF A03

In order to better describe the time dependent variations in the experimental data from the laboratory experiments a first order acoustical analysis was performed. The results of this analysis are presented in the Appendix. The most important result is that the longitudinal acoustical modes for a spatial varying particle density are time dependent. Thus, it is likely that the time dependence observed in the laboratory tests is due to the lack of a standing wave solution, not due to time dependent nonuniformity caused by the apparatus. The experimental evidence to support this is qualitative at this time. The experience with the Acoustical Resonance Measurement (ARM) using transverse resonances is that particle density nonuniformity tends to change the resonance frequency shift on the time scale of the batch of fluidized particles moving through the cross section under test, the shift is in the direction of the increase or decrease, and the magnitude of the frequency shift recovers once steady behavior is attained. However with longitudinal resonances, the amplitude tended to oscillate and these oscillations could not be averaged out. A comprehensive explanation which links the experimental data and the theory has not yet been accomplished. DOE

N91-24563# Sandia National Labs., Albuquerque, NM.
ANALYSIS OF AN EBeam MELTING PROCESS
P. R. Schunk 1991 6 p Presented at the 4th FIDAP Users Conference, Evanston, 14-16 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-010855; SAND-90-2789C; CONF-9104202-2) Avail: NTIS HC/MF A02

Electron-Beam (EBeam) melting furnaces are routinely used to minimize the occurrence of second-phase particles in the processing of segregation-sensitive alloys. As one part of the process, a circulating electron beam impinges the surface of a crucible melt pool to help control the shape of the solidification front below. By modeling melt pool hydrodynamics, heat transfer, and the shape of solidification boundaries, we plan to optimize the dwell pattern of the beam so that the material solidifies with a composition as spatially homogeneous as possible. Both two-and three-dimensional models are being pursued with FIDAP 5.02, the former serving as a test bed for various degrees of model sophistication. A heat flux distribution is specified on the top of the domain to simulate the EBeam dwell pattern. In two dimensions it is found that an inertially-driven recirculation in the melt pool interacts with a counter-rotating buoyancy-driven recirculation, and that both recirculation influence heavily the shape of the solidification front. In three dimensions the inertial cell decays quickly with distance from the position of the inlet stream. Because the Rayleigh number can exceed 10(exp 7) for materials and operating conditions of interest, stability and the possibility of spontaneous transients are explored. DOE

N91-24564# International Centre for Theoretical Physics, Trieste (Italy).
INVESTIGATION OF SURFACE DEFORMATIONS BY DOUBLE EXPOSURE HOLOGRAPHIC INTERFEROMETRY
F. N. Ecevit, H. Guven (Middle East Technical Univ., Ankara, Turkey), and R. Aydin Mar. 1990 10 p
(DE91-619238; LAMP-90/1) Avail: NTIS HC/MF A02

Surface deformations of rigid bodies produced by thermal as well as mechanical strains have been investigated using double-exposure holographic interferometry. The recorded interference fringes have been discussed qualitatively. DOE

N91-24565*# Wisconsin Univ., Madison. Dept. of Electrical and Computer Engineering.
HIGH FREQUENCY LOSSES IN INDUCTION MOTORS, PART 2 Final Report
Donald W. Novotny and Syed A. Nasar Jun. 1991 138 p
(Grant NAG3-940)
(NASA-CR-188443; NAS 1.26:188443) Avail: NTIS HC/MF A07 CSCL 14B

The following subject areas are covered: high frequency losses in induction motors; stray losses in induction motors; and high frequency time harmonic losses in induction motors. Author

N91-24566*# Ball Aerospace Systems Div., Muncie, IN.
FLUID QUANTITY GAGING Final Report
Allan J. Mord, Howard A. Snyder, Kathleen A. Kilpatrick, Lynn A. Hermanson, Richard A. Hopkins, and Donald A. VanGundy 5 Dec. 1988 235 p
(Contract NAS9-17616)
(NASA-CR-185516; NAS 1.26:185516; F88-06-102A) Avail: NTIS HC/MF A11 CSCL 14B

A system for measuring the mass of liquid in a tank on orbit with 1 percent accuracy was developed and demonstrated. An extensive tradeoff identified adiabatic compression as the only gaging technique that is independent of gravity or its orientation, and of the size and distribution of bubbles in the tank. This technique is applicable to all Earth-storable and cryogenic liquids of interest for Space Station use, except superfluid helium, and can be applied to tanks of any size, shape, or internal structure. Accuracy of 0.2 percent was demonstrated in the laboratory, and a detailed analytical model was developed and verified by testing. A flight system architecture is presented that allows meeting the needs of a broad range of space fluid systems without custom development for each user. Author

N91-24259# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
NONCONTACTING MULTIPARAMETRIC SENSOR FOR SHAFT SPEED, TORQUE, AND POSITION
A. Schwartzbart *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 281-289 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

N91-24318*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF THE INSTRUMENTATION PROGRAM Abstract Only
William C. Nieberding *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 81-82 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 14B

N91-24321*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CALIBRATOR TESTS OF HEAT FLUX GAUGES MOUNTED IN SSME BLADES
Curt H. Liebert *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 99-104 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 14B

N91-24322*# Physical Research, Inc., Torrance, CA.
DEVELOPMENT OF FIBER-BASED LASER ANEMOMETER FOR SSME APPLICATION
Dariush Modarress and Robert Fan *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 105-112 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 14B

N91-24323*# Case Western Reserve Univ., Cleveland, OH. Dept. of Mechanical Engineering.
ANALYSIS OF THE TRANSIENT CALIBRATION OF HEAT FLUX SENSORS: ONE DIMENSIONAL CASE
A. Dybbs and J. X. Ling *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 113-122 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 14B

N91-24624*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE DYNAMIC TORQUE CALIBRATION UNIT: AN INSTRUMENT FOR THE CHARACTERIZATION OF BEARINGS USED IN GIMBAL APPLICATIONS
Louise Jandura *In its* The 25th Aerospace Mechanisms Symposium May 1991 p 307-322 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 14B

N91-24973*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
LDEF ATTITUDE MEASUREMENT USING A PINHOLE CAMERA WITH A SILVER/OXYGEN ATOM DETECTOR Abstract Only
John C. Gregory (Alabama Univ., Huntsville.) and P. N. Peters *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 3 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 14B

N91-24975*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
USE OF THE LONG DURATION EXPOSURE FACILITY'S THERMAL MEASUREMENT SYSTEM FOR THE VERIFICATION OF THERMAL MODELS Abstract Only
William M. Berrios *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 5 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 14B

N91-25075*# Instruments Service Aerodynamique, Longjumeau (France). Grating Dept.
RULED AND HOLOGRAPHIC GRATINGS EXPERIMENT (AO 138-5) Abstract Only
Francis Bonnemason *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 109 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20E

36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

N91-24567 Georgia Inst. of Tech., Atlanta.
NOISE IN SEMICONDUCTOR LASERS Ph.D. Thesis
George Robert Gray 1990 281 p
Avail: Univ. Microfilms Order No. DA9105435

An experimental and theoretical study of semiconductor lasers is presented. The emphasis is on the influence of noise on the laser characteristics and the competition between the longitudinal modes through the nonlinear gain. The standard rate equations are derived from quantum theory. The resulting equations are integrated on the computer for the important practical case of the nearly-single-mode laser. The influence of a small side mode on the field fluctuations of the main mode can lead to a contribution to the power-independent linewidth. A nonlinear gain model incorporating a gain curve which is asymmetric with respect to its peak is adapted and used to explain the observed regions of bistable and multimode behavior. The problem of mode hopping, the spontaneous switching between two longitudinal modes, is studied in detail through both experiments and computer simulations, by the formation of dwell time histograms.
Dissert. Abstr.

N91-24568# Letterman Army Inst. of Research, San Francisco, CA.
RESULTS OF A PILOT STUDY: TARGET IDENTIFICATION USING COMPUTER VISUAL SIMULATION OF LASER-INDUCED CONTRAST SENSITIVITY DEFICITS Report, period ending Jun. 1990
Jeffrey D. Gunzenhauser, Eric F. Holt, Harry Zwick, Jerome W. Molchany, and George R. Mastroianni Sep. 1990 25 p
(AD-A232899; LAIR-455) Avail: NTIS HC/MF A03 CSCL 09/3

In a pilot study a set of computerized military-relevant images was developed and a subset of these used in a target recognition performance study. Images were created by digitizing video images of four model tanks placed in a simulated terrain environment. Images varied by country of tank, orientation of the tank, and viewing distance. Each image was passed through an empirically derived filter to simulate changes in contrast sensitivity following acute laser exposure. A subset of the original images and their corresponding filtered images were used in a human performance study. Six subjects were initially trained to recognize only the unfiltered images. Image-processing software and hardware were used to present and modify the contrast of images according to a standardized rate and sequence. During the study, images were presented in pairs and subjects were forced to choose the first image that became recognizable. GRA

N91-24569# Department of the Navy, Washington, DC.
A BURIED HETEROSTRUCTURE LASER MODULATOR Patent Application
Daniel L. Rode, inventor (to Navy) and John C. Sciortino, inventor (to Navy) 31 Oct. 1990 16 p
(AD-D014819; US-Patent-Appl-SN-607390) Avail: NTIS HC/MF A03 CSCL 09/5

A buried-heterostructure laser modulator for modulating a laser beam includes two adjacent thin epitaxial first layers of oppositely doped semi-conductor material and a thin epitaxial buried layer of undoped semi-conductor material located between the two adjacent first layers. The buried layer forms a single mode optical channel having a width larger than a height thereof with the width equal to or greater than a width of a diffraction limited waveguide mode of the laser beam. Two thin epitaxial second layers of similarly and heavily doped semiconductor material are provided respectively adjacent the respective first layers of the same doping. One of these second layers is provided on a side of a semi-insulating substrate and two strip lines of opposite bias are provided on the side of the substrate and connect to a respective second layer of the same bias. The two adjacent first layers are preferably AlGaAs and the buried layer is preferably GaAs with a width less than about 1.5 microns and a height about 0.2 microns. GRA

N91-24570# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
FREQUENCY UP-CONVERSION OF 10.6 MICRONS LASER
Mali Gong and Kai Han 7 Nov. 1990 12 p Transl. into ENGLISH from Jiguang Zazhi (Peoples Rep. of China), v. 7, no. 1, 1986 p 8-10
(AD-A233038; FTD-ID(RS)T-0741-90) Avail: NTIS HC/MF A03 CSCL 09/3

The paper studies the frequency up-conversion process of a 10.6 micron laser in an AgGaS2 nonlinear crystal, and presents the results of calculating the phase matching angle, the phase matching acceptance angle, and the effective bandwidth of 10.6 micron light. Thus, the frequency conversion of 10.6 micron light to 0.967 micron light is realized. In the nonfocussing mode, the maximum power conversion efficiency is greater than 7 percent. The eta(theta) and eta(lp) curves were measured; the optimal phase matching angle is 38 deg 50 min for type II. Multiple factors that affect conversion efficiency are analyzed; the major noise sources of the upconversion system of an infrared detector are also analyzed. GRA

N91-24571# Science Research Lab., Inc., Somerville, MA.
AN ALL-SOLID-STATE CO2 LASER DRIVER Final Report, 1 Jun. 1988 - 31 Mar. 1991
Daniel Birx 31 Mar. 1991 190 p
(Contract N00014-88-C-0507)
(AD-A233212; SRL-03-F-1991) Avail: NTIS HC/MF A09 CSCL 09/3

New, all-solid-state pulse generators are described which meet military requirements for an efficient, reliable pulsed power source to drive a space based CO2 laser. These SCR-commutated, nonlinear magnetic pulse compressors are fully-compatible with the present Spectra Technologies laser head design planned for use on LOWKATER. By employing SCRs rather than thyratron commutators, these pulsers should provide a significant increase in reliability over the current generation of pulsed power drivers. The first pulser which was designed and constructed was denoted COLD-I. COLD-I was designed to meet the original LOWKATER specifications and delivered at 150 joule, 20 kV pulse into a laser load at 10 to 20 Hz repetition rate. The second pulser, denoted COLD-II, was designed to provide a 45 joule, 500 nsec duration pulse at a voltage of 20 kV and a repetition rate of 1 kHz peak and 50 to 100 Hz average. The electrical efficiency was measured to be 80 percent with an input drive of 500 VDC. This pulse served as a design verification testbed for a third pulser, presently designed but not constructed and denoted COLD-III. COLD-III would be capable of producing 36 joules at the same pulse length and repetition rate at voltages of 20 kV. The Phase-II effort was a high risk, high payoff effort aimed at developing a light weight, high reliability RF power source for advanced RF CO2 laser heads under development. COLD-IV a Branched Magnetic RF Nonlinear Magnetic Pulse Compressor was built as a bread GRA

N91-24572# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Technology Div.
RESEARCH ON INDUSTRIAL 10kW CO2 LASER ACHIEVES MAJOR BREAKTHROUGH
24 Jan. 1991 5 p Transl. into ENGLISH from Zhong Guo Gao Deng Jiao Yu (China), no. 12, 1989 p 41
(AD-A233273; FTD-ID(RS)T-1042-90) Avail: NTIS HC/MF A01 CSCL 09/3

The industrial 10kW CO2 laser is one of the items which the industrially developed nations are competing to develop. This laser is capable of continuous output power of over 10kW and can operate continuously for more than 6 hours. The 10kW CO2 laser developed as a key task of China's 7th Five-Year Plan and all its technological targets such as output power, electrooptical conversion efficiency and primary charging continuous operating time, have reached the level of world advancement, allowing China to enter the ranks of international advancement in the area of laser technology. The industrial 10kW CO2 laser can have wide application in such areas of industry as heat treating, machining, welding and surface treatment in industries such as steel, automobiles, ship building and aircraft manufacturing. For instance, using the high-efficiency laser beams of this 10kW laser to treat rollers, fan blades and automotive cylinder blocks can increase the life of these parts and produce large economic benefits. At present, industrial tests of gear welding is already being done on this 10kW laser. GRA

N91-24573# Department of the Navy, Washington, DC.
LASER BEAM PHASE MEASUREMENT AND CONTROL SYSTEM Patent
Leonard S. Taylor, inventor (to Navy) 5 Feb. 1991 6 p Filed 21 Dec. 1981
(AD-D014853; US-Patent-4,990,762; US-Patent-Appl-SN-332796; US-Patent-Class-250-201.8) Avail: US Patent and Trademark Office CSCL 09/3

An intensity measurement system portion of a phase measurement and control system permits rapid measurement of the laser field intensity profile in transverse plane of a main laser beam. The intensity measurement system portion measures the laser field intensity profile by measuring the intensities of a plurality of beam samples of the main laser beam. The aforementioned measured intensities are processed in a phase computer according to a predetermined algorithm to generate drive current profiles in response to the phase variations of the main laser beam. These

drive currents a dither-control amplifier which causes electromechanical movement of a plurality of mirror segments of a multi-dither mirror to correct for the random phase variations in the main laser beam. An important consideration in configuring the intensity measurement system portion of the present invention is the use of a reflecting stop and a reflecting stop detector combination to obstruct one of plurality of beam samples and to measure the intensity thereof at the reflecting stop position.
GRA

N91-24574# EG and G Energy Measurements, Inc., Idaho Falls.
CHARACTERISTICS OF PULSED NUCLEAR REACTOR PUMPED FLOWING GAS LASERS
W. A. Neuman and J. R. Fincke 1991 13 p Presented at the OE/LASE 1991: 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, 20-25 Jan. 1991
(Contract DE-AC07-76ID-01570)
(DE91-010054; EGG-M-91041; CONF-910123-21) Avail: NTIS HC/MF A03

Nuclear reactors offer very large energy sources to pump lasers without the need for external power supplies. The large energy deposition possible in nuclear reactor pumped lasers (NRPLs) requires a flowing gas system to control thermal effects. A NRPL amplifier pumped by charged particles originating in fuel films parallel to a flowing buffer gas is presented. A 10 ms full width half maximum Gaussian reactor pulse is specified and the flow velocity in the cavity is varied to investigate the amplifier behavior for hydrodynamic time scales shorter, comparable, and longer than the reactor time scale. The index of refraction aberration in the cavity is dominated by a tilt in the flow direction and a cylindrical focus transverse to the flow. Higher order aberrations are also significant and exhibit complex behavior during the pulse as the hydrodynamic time scale becomes long compared with the time scale of the reactor pulse. The far field beam quality resulting from the combined 3rd and 4th order aberrations is found to correlate well with the maximum index aberration in the aperture and not with the average power deposition. This correlation breaks down when the 4th order aberrations become significant and the qualitative nature of the aberration changes. DOE

N91-24575# Gandhi (Indira) Centre for Atomic Research, Kalpakkam (India).
CREEP RUPTURE PROPERTIES OF SOLUTION ANNEALED AND COLD WORKED TYPE 316 STAINLESS STEEL CLADDING TUBES
M. D. Mathew, S. Latha, S. L. Mannan, and P. Rodriguez 1990 40 p
(DE91-618658; IGC-117) Avail: NTIS HC/MF A03

Austenitic stainless steels (mainly type 316 and its modifications) are used as fuel cladding materials in all current generation fast breeder reactors. For the Fast Breeder Test Reactor (FBTR) at Kalpakkam, modified type 316 stainless steel (SS) was chosen as the material for fuel cladding tubes. In order to evaluate the influence of cold work on the performance of the fuel element, the investigation was carried out on cladding tubes in three metallurgical conditions (solution annealed, ten percent cold worked, and twenty percent cold worked). The results indicate that: (1) the creep strength of type 316 SS cladding tube increases with increasing cold work; (2) the benificial effects of cold work are retained at almost all the test conditions investigated; and (3) the Larson Miller parameter analysis shows a two slope behavior for 20 PCW material suggesting that caution should be exercised in extrapolating the creep rupture life to stresses below 125 MPa. At very low stress levels, the LMP values fall below the values of the 10 PCW material. DOE

N91-24320*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OPTICAL INSPECTION OF SPACE-PROPULSION COMPONENTS USING AN INJECTION SEEDED Nd:YAG LASER SYSTEM
Arthur J. Decker *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 87-98 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20E

37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

N91-24576 Arizona State Univ., Tempe.
CONTROL OF MECHANICAL VIBRATIONS IN A CIRCULAR DISK Ph.D. Thesis
Chang-Chiun Huang 1990 101 p
Avail: Univ. Microfilms Order No. DA9101886

Mechanical vibration is a common phenomena observed in the operation of many machines. While many control system designs which are aimed at eliminating vibrations occurring in distributed parameter systems have already been proposed in the literature, generally they either are based on truncated models and, as a result, suffer from computational and 'spillover' difficulties or require distributed parameter actuators which are rarely available in reality. The use of linear compensators whose design is based on root locus arguments for exact infinite dimensional systems is proposed. Since this approach is not based on any finite dimensional approximation model of the plant to be controlled, it is expected to perform well for those distributed parameter systems for which sufficiently accurate information on pole-zero patterns can be obtained. To demonstrate the effectiveness of this approach, it is adopted to stabilize mechanical vibrations occurring in a centrally-clamped, flexible circular disk. This system can be considered as a generic model of many machine elements. For a pair of colocated actuator and sensor, the transfer function between them has open loop poles and zeros interlacing on the imaginary axis. Therefore, a simple velocity feedback or a lead compensator with position feedback can drive all the closed loop poles into the open left half plane. For non-colocated actuator and sensor, the interlacing pole-zero pattern can still be retained for the lower frequency vibration modes by properly positioning actuator and sensor along the same radial direction. Under such control hardware configuration, stabilization of all vibration modes can be achieved by adopting a compensator design with low-pass feature and 0 to 180 deg phase shift, and the existence of a minimal amount of internal structural damping can fully eliminate the possibility of instability. Dissert. Abstr.

N91-24577*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
METHOD AND APPARATUS FOR RELEASABLY CONNECTING FIRST AND SECOND OBJECTS Patent Application
Leo G. Monford, Jr., inventor (to NASA) 13 Feb. 1991 20 p
(NASA-Case-MSC-21517-1; NAS 1.71:MSC-21517-1; US-Patent-Appl-SN-654704) Avail: NTIS HC/MF A03 CSCL 13I

The apparatus and method are disclosed for releasably connecting first and second objects, where a magnetic end effector may include at least one elongated pin number, a proximal end of which is connected to the first object and the distal end of which may be inserted into a receiving portion in the second object. Latch members are carried by the pin member for radial movement between retracted and expanded positions for releasing and locking, respectively, first and second objects. A plunger member carried by the pin member is axially moveable between first and second positions. In the first plunger position, the latch members are located in the expanded (locked) position and in the second plunger position the latch members are released for movement to retracted or unlocked position. The magnetic end effector is provided for releasable attachment to the first object and for moving the plunger member to the second position, releasing the first object. NASA

N91-24578 Iowa Univ., Iowa City.
NUMERICAL METHODS FOR CONSTRAINED EQUATIONS OF MOTION IN MECHANICAL SYSTEMS DYNAMICS Ph.D. Thesis
Jeng Yen 1990 125 p
Avail: Univ. Microfilms Order No. DA9103282

A new class of methods for solving the equations of motion of constrained mechanical systems is developed. The technique used for solving differential algebraic equations for constrained mechanical motion is based on reducing the problem to a system of Ordinary Differential Equations (ODEs) and a system of algebraic equations. All the valid methods that can formulate the system as ODEs are derived by differentiating the kinematic constraints twice to obtain information on the second derivative of the generalized coordinates. The most important requirements of the solution of reduced ODEs is that they satisfy kinematic constraints, which are recognized as invariant of the problem. Recent developments in continuation methods and studies in differential geometry are used in solving these ODEs with invariants. In the framework of the numerical methods developed, both explicit and implicit numerical integration can be used in solving reduced ODEs. Error analysis of the numerical solution of the proposed methods is carried out through the newly developed formalism. Concepts of generalized coordinate partitioning and tangent spaces are used to parameterize the kinematic constraint set. Dissert. Abstr.

N91-24579 California Univ., Irvine.
DESIGN AND PLANNED MOVEMENT OF MULTI-DEGREE OF FREEDOM SPATIAL MECHANISMS Ph.D. Thesis
Radhika Mohan Chouda Bodduluri 1990 182 p
Avail: Univ. Microfilms Order No. DA9104562

A general methodology is presented for the design of multi-degree of freedom spatial mechanisms and a new strategy for planning their movement. The closed chain is the focus of interest, though the methodology applies to open chains as well. The focus is on specifying dimensions for these systems that position a workpiece in a set of prescribed locations. Motion planning is required to ensure that these systems are able to move between these prescribed positions. The methodology presented is a unified approach for the design of open and closed chains independent of the number of degrees of freedom. The design goal is formulated as a set of precision positions specified for a distinguished body in the chain, such as the end effector in an open chain, or the workpiece in a cooperating robot system. The positions are mapped to points in the so-called image space of rigid displacements. In this space, position constraints on the body imposed by a kinematic chain define an algebraic manifold representing all the positions available to the body. The design problem becomes identifying the link dimensions that fit the constraint manifold to the desired positions. Constraint manifolds for various open chains are derived, which can be combined to form the manifolds for closed chains. Numerical examples of design are provided for the cases of 4R spherical closed chains, 2S open chains, 4S closed chains, and cooperating PUMA robot systems. The multi-degree of freedom mechanism obtained from the design procedure is guaranteed to position the body at the prescribed locations, however movement from one position to another may not be possible due to self-collision or singularities of the kinematic chain. Therefore a general algorithm to plan movements was developed to supplement the design. The strategy uses tests and refines a web of one degree of freedom moves in the joint space seeking a feasible path. This algorithm converges to find a feasible path if one exists. Examples of path planning are presented for 5R and 6R planar closed chains with obstacles, two cooperating PUMA manipulators, and two cooperating Robotics Research Arms. Dissert. Abstr.

N91-24580 California Univ., Berkeley.
INNOVATIVE DESIGN OF MECHANICAL STRUCTURES FROM FIRST PRINCIPLES Ph.D. Thesis
Jonathan Cagan 1990 292 p
Avail: Univ. Microfilms Order No. DA9103641

Design is a complex phenomenon which often requires solutions beyond the routine. Generation of innovative designs in the mechanical/structural domain requires deep level reasoning capabilities to determine how to modify an existing design. It is proposed that computational methodologies can innovate optimally directed designs by reasoning from first principle knowledge. A non-routine design methodology called 1st PRINCE (FIRST PRINciple Computational Evaluator) based on the assumption that the creation of innovative designs of physical significance requires first principle knowledge to reason about geometric and material properties is introduced. The innovative designs discovered by 1st PRINCE differ from routine designs in that new prototypes are created. Monotonicity analysis and computer algebra algorithms drive design variables in an optimal direction relative to the goals specified. Manipulating mathematical quantities, in order to satisfy the constraints or improve the design, expands the design space and innovates new prototypes. The technique of Dimensional Variable Expansion is developed to perform the manipulation in structural domains. Inductive techniques observe trends in successive iterations to observe the optimally directed limit of the design modifications. A graph-theoretic representation was developed to provide an environment which supports non-routine design of physical structures by considering geometric connectivity. The resulting design method requires a knowledge base only of fundamental equations of deformation with physical constraints on variables, constitutive relations, and fundamental engineering assumptions; no precompiled knowledge of mechanical behavior is needed. Dissert. Abstr.

N91-24581 Michigan State Univ., East Lansing.
CONTROL OF SINGLE-LINK FLEXIBLE MANIPULATORS FABRICATED FROM ADVANCED COMPOSITE LAMINATES AND SMART MATERIALS INCORPORATING ELECTRO-RHEOLOGICAL FLUIDS Ph.D. Thesis
Seung-Bok Choi 1990 264 p
Avail: Univ. Microfilms Order No. DA9102656

Three different control schemes for a single-link flexible manipulator fabricated from composite laminates or smart materials incorporating electro-rheological fluids are developed: an output feedback controller, a hybrid controller, and a nonlinear state feedback controller. The output feedback controller featuring two colocated sensors is designed by utilizing the root-locus technique and the Lyapunov method after a description of the dynamic modeling of the flexible manipulator. The hybrid controller which consists of an output feedback controller and a pseudo-state feedback controller is proposed for the flexible manipulator fabricated from smart materials incorporating electro rheological fluids. A phenomenological equation of motion is developed from experimental observations of the modal characteristics, and an empirical model of a distributed electro rheological fluid actuator which characterizes the pseudo-state feedback controller is obtained as an explicit function of the electrical intensities. The nonlinear state feedback controller is developed for the flexible manipulator fabricated from composite laminates. The effects of each uncertain parameter as well as the interaction of all parameters are considered without assuming matching conditions. The properties of the uniform and uniform ultimate boundedness of the solution of system state equations are employed to formulate the controller. Dissert. Abstr.

N91-24582*# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Electrical, Systems, and Computer Engineering.
A PASSIVITY BASED CONTROL METHODOLOGY FOR FLEXIBLE JOINT ROBOTS WITH APPLICATION TO A SIMPLIFIED SHUTTLE RMS ARM Annual Report
Pierre Sicard and John T. Wen 1991 89 p
(Grant NAG9-462)
(NASA-CR-188176; NAS 1.26:188176) Avail: NTIS HC/MF A05 CSCL 13I

The main goal is to develop a general theory for the control of flexible robots, including flexible joint robots, flexible link robots, rigid bodies with flexible appendages, etc. As part of the validation, the theory is applied to the control law development for a test example which consists of a three-link arm modeled after the shoulder yaw joint of the space shuttle remote manipulator system

(RMS). The performance of the closed loop control system is then compared with the performance of the existing RMS controller to demonstrate the effectiveness of the proposed approach. The theoretical foundation of this new approach to the control of flexible robots is presented and its efficacy is demonstrated through simulation results on the three-link test arm. Author

N91-24583*# Iowa State Univ. of Science and Technology, Ames. Dept. of Mechanical Engineering.
SIMULATION OF A COMBINED-CYCLE ENGINE Final Report
Jon VanGerpen 10 Jun. 1991 47 p
(Grant NAG3-957)
(NASA-CR-188232; NAS 1.26:188232) Avail: NTIS HC/MF A03 CSCL 10B

A FORTRAN computer program was developed to simulate the performance of combined-cycle engines. These engines combine features of both gas turbines and reciprocating engines. The computer program can simulate both design point and off-design operation. Widely varying engine configurations can be evaluated for their power, performance, and efficiency as well as the influence of altitude and air speed. Although the program was developed to simulate aircraft engines, it can be used with equal success for stationary and automative applications. Author

N91-24584*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
EFFECT OF FLANGE BOLT PRELOAD ON SPACE SHUTTLE MAIN ENGINE HIGH PRESSURE OXIDIZER TURBOPUMP HOUSING ANALYSIS
J. B. Min, L. M. Johnston, and B. Czekalski (Intergraph Corp., Huntsville, AL.) May 1991 36 p
(NASA-TM-103536; NAS 1.15:103536) Avail: NTIS HC/MF A03 CSCL 13K

Cracks at the seal fillet flange and the strut pilot groove of primary turbine drain passage of the space shuttle main engine (SSME) high pressure oxidizer turbopump (HPOTP) were observed and reported. Stress information for critical structural components in the SSME under actual conditions is necessary for design and life prediction analysis. However, little information is available about the stress distribution at this location under various combinations of loadings and environments. Thus, a stress analysis was conducted to determine an influence of the various operation and installation loads on the stresses of the HPOTP main mounting flange. To do this, a 3-D finite element model of the HPOTP housing was generated. A fairly comfortable margin of stresses at the flange fillet with respect to the yield stress of Inconel 718 is shown. However, it was revealed that the bending stress arising from the housing flange bolt preloads could significantly affect the stress distribution at the strut pilot groove of primary turbine drain passage in the HPOTP housing. Consequently, the information obtained from the present 3-D analysis results should be useful in guiding the development of the SSME HPOTP. Author

N91-24585# Illinois Univ., Urbana. Decision and Control Lab.
AUTOMATED ARC WELDING SYSTEM
James H. Ross Mar. 1991 44 p
(Contract DACA88-90-D-0003)
(AD-A232890; UILU-ENG-91-2213; DC-128) Avail: NTIS HC/MF A03 CSCL 11/6

An experimental automated arc welding system is presented. A general overview of the system capabilities is given. This is followed by a more detailed description of the new measurement techniques which have been incorporated. A description of the control system structure includes details of some implementation considerations. This is followed by an example of a controller which has been implemented. Finally, suggestions for further research are presented. GRA

N91-24586# Department of the Navy, Washington, DC.
RING DAMPER FOR STRUCTUREBORNE NOISE SUPPRESSION IN PIPING SYSTEMS Patent Application
Kam W. Ng, inventor (to Navy) 3 Oct. 1990 10 p
(AD-D014818; US-Patent-Appl-SN-592035) Avail: NTIS HC/MF A02 CSCL 13/11

A ring damper is disclosed for reducing vibration and structureborne noise propagation in piping systems. A metal ring is clamped circumferentially around the outer surface of the pipe or duct. The ring defines an annular chamber or cavity that is stuffed with a combination of damping materials. GRA

N91-24587# Department of the Navy, Washington, DC.
LOW FREQUENCY VIBRATION ABSORBER Patent Application
Neil J. Dubois, inventor (to Navy) and Benoit G. Gauthier, inventor (to Navy) 24 Sep. 1990 13 p
(AD-D014820; US-Patent-Appl-SN-589703) Avail: NTIS HC/MF A03 CSCL 19/8

This patent application discloses a mounting assembly for absorbing low frequency vibrational energy as produced by a source and isolating a base member therefrom. The mounting assembly includes a central metallic ring, non-metallic foam rings located on both sides of the central metallic ring in concentric relation. Inner and outer metallic ring members engage the foam rings in concentric relation. The foam rings define a spongy mass that effectively absorbs the low frequency vibrational energy emanating from the source. GRA

N91-24588# Colorado School of Mines, Golden. Center for Welding Research.
SHIELDED METAL ARC WELDING CONSUMABLES FOR ADVANCED HIGH STRENGTH STEELS Annual Progress Report
G. R. Edwards and S. Liu Feb. 1991 48 p
(Contract N00014-89-J-3170)
(AD-A233376; CSM-MT-CWR-091-006) Avail: NTIS HC/MF A03 CSCL 13/5

To achieve the goal of developing adequate shielded metal arc (SMA) welding consumables for advanced high strength steels, characterization of the complex relationship between the core rod and the flux coating is required. An adequate core rod/flux coating combination will result in an improved ability to protect the transfer of desired chemical elements into the weld pool, and will influence the final weld metal composition and microstructure. Prior to the extrusion of experimental SMA welding electrodes, submerged arc (SA) welding experiments were conducted to investigate and characterize the pyrometallurgy of the weld pool, weld metal microstructure and mechanical properties. An alloyed core wire, Airco AX-140, was used, together with fluxes prepared from commercial grade purity chemicals, in this research. Of specific interest is the influence of systematic variations in flux composition on the welding behavior. GRA

N91-24589# Cranfield Inst. of Tech., Bedford (England). Dept. of Turbomachinery and Engineering Mechanics.
RADIAL INFLOW TURBINE STUDY Interim Report, No. 4, 15 Jul. - 21 Dec. 1990
S. Hamid and R. L. Elder Jan. 1991 8 p
(Contract DAJA45-89-C-0006)
(AD-A233623; CIT-REF-06/769E(4); R/D-5824-AN-01) Avail: NTIS HC/MF A02 CSCL 20/4

The radial inflow turbine is a primary component used both in small gas turbines and turbochargers. Better understanding of the flow processes occurring within the small passages of the machine could well result in the improved design of units. As most of the detailed aerodynamics is still ill-defined, a joint research project with the objective of improving our understanding has been investigated. This document describes the manufacture of the window arrangement, the preparation of seeding systems for the laser anemometer, assembly, and trial of the anemometer. GRA

N91-24590# Department of the Navy, Washington, DC.
METHOD OF STEERING THE GAIN OF A MULTIPLE ANTENNA GLOBAL POSITIONING SYSTEM RECEIVER Patent Application
Alan G. Evans, inventor (to Navy) and Bruce R. Hermann, inventor

(to Navy) 16 Nov. 1990 12 p
(AD-D014848; US-Patent-Appl-SN-621685) Avail: NTIS HC/MF A03 CSCL 17/7

A method for steering the gain of a multiple antenna Global Positioning System (GPS) receiver toward a plurality of GPS satellites simultaneously is provided. The GPS signals of a known wavelength are processed digitally for a particular instant in time. A range difference or propagation delay between each antenna for GPS signals received from each satellite is first resolved. The range difference consists of a fractional wavelength difference and an integer wavelength difference. The fractional wavelength difference is determined by each antenna's tracking loop. The integer wavelength difference is based upon the known wavelength and separation between each antenna with respect to each satellite position. The range difference is then used to digitally delay the GPS signals at each antenna with respect to a reference antenna. The signal at the reference antenna is then summed with the digitally delayed signals to generate a composite antenna gain. The method searches for the correct number of integers wavelengths to maximize the composite gain. The range differences are also used to determine the attitude of the array. GRA

N91-24591# Oak Ridge National Lab., TN.
CONTROLLER DESIGN FOR A FORCE-REFLECTING TELEOPERATOR SYSTEM WITH KINEMATICALLY DISSIMILAR MASTER AND SLAVE
J. F. Jansen, R. L. Kress, and S. M. Babock 1990 23 p Presented at the American Society of Mechanical Engineers (ASME) Winter Annual Meeting, Dallas, 25-30 Nov. 1990
(Contract DE-AC05-84OR-21400)
(DE91-010187; CONF-901194-15) Avail: NTIS HC/MF A03

A controller was developed for a force reflecting teleoperator system having kinematically dissimilar master and slave. The controller is a stiffness controller for both the master and the slave. A mathematical problem associated with representing orientations using Euler angles is described, and Euler parameters are proposed as a solution. The basic properties of Euler parameters are presented, specifically those pertaining to stiffness control. The stiffness controller for both the master and the slave is formulated using Euler parameters to represent orientation and a Liapunov stability proof is presented for the controller. The master portion of the control scheme is implemented on a 6 degree-of-freedom master. DOE

N91-24592# Oak Ridge National Lab., TN.
USE OF FORCE-MEASURING TRANSDUCERS IN MANIPULATOR CONTROL
J. F. Jansen and R. L. Kress 1991 17 p Presented at the 1991 Society for Experimental Mechanics Spring Conference, Milwaukee, 9-13 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010809; CONF-9106131-3-Pt-1) Avail: NTIS HC/MF A03

This paper investigates two types of control structures for teleoperated manipulators using force-measuring transducers; each control structure type targets specific properties of the manipulator. One approach is to measure torque in the drive train of the manipulator to increase backdriveability, sensitivity, and stiffness. The second approach is to measure the forces and torques at the wrist of the manipulator, and then use this force/torque vector in a stiffness control algorithm which resolves dissimilar kinematics and to increase sensitivity. DOE

N91-24593*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPARISON OF WEIBULL STRENGTH PARAMETERS FROM FLEXURE AND SPIN TESTS OF BRITTLE MATERIALS
Frederic A. Holland, Jr. and Erwin V. Zaretsky 1991 11 p Presented at the Ninth Biennial Conference on Reliability, Stress Analysis, and Failure Prevention, Miami, FL, 22-25 Sep. 1991; sponsored by ASME
(NASA-TM-104414; E-6245; NAS 1.15:104414) Avail: NTIS HC/MF A03 CSCL 13H

Fracture data from five series of four point bend tests of beam and spin tests of flat annular disks were reanalyzed. Silicon nitride and graphite were the test materials. The experimental fracture strengths of the disks were compared with the predicted strengths based on both volume flaw and surface flaw analyses of four point bend data. Volume flaw analysis resulted in a better correlation between disks and beams in three of the five test series than did surface flaw analysis. The Weibull (moduli) and characteristic gage strengths for the disks and beams were also compared. Differences in the experimental Weibull slopes were not statistically significant. It was shown that results from the beam tests can predict the fracture strength of rotating disks. Author

N91-24594*# Southwest Research Inst., San Antonio, TX.
ON-ORBIT COMPRESSOR TECHNOLOGY PROGRAM Final Report
Danny M. Deffenbaugh, Steven J. Svedeman, Edgar C. Schroeder, and C. Richard Gerlach Oct. 1990 188 p
(Contract NAS9-18051; SwRI Proj. 04-2529)
(NASA-CR-185645; NAS 1.26:185645) Avail: NTIS HC/MF A09 CSCL 13I

A synopsis of the On-Orbit Compressor Technology Program is presented. The objective is the exploration of compressor technology applicable for use by the Space Station Fluid Management System, Space Station Propulsion System, and related on-orbit fluid transfer systems. The approach is to extend the current state-of-the-art in natural gas compressor technology to the unique requirements of high-pressure, low-flow, small, light, and low-power devices for on-orbit applications. This technology is adapted to seven on-orbit conceptual designs and one prototype is developed and tested. Author

N91-24595# Tecogen, Inc., Waltham, MA.
WEAR REDUCTION SYSTEMS LIQUID PISTON RING
R. J. Raymond, T. N. Chen, and L. DiNanno Sep. 1990 79 p
(Contract DE-AC21-88MC-25035)
(DE91-002036; DOE/MC-25035/2940) Avail: NTIS HC/MF A05

The overall objective of the program was to demonstrate the technical feasibility of achieving an acceptable wear rate for the cylinder liner, piston, and piston rings in a coal/water-slurry-fueled engine that utilized the concept of a liquid piston ring above the conventional piston rings and to identify technical barriers and required research and development. The study included analytical modeling of the system, a bench study of the fluid motion in the liquid piston ring, and a single-cylinder test rig for wear comparison. A system analysis made on the different variations of the liquid supply system showed the desirability of the once-through version from the standpoint of system simplicity. The dynamics of the liquid ring were modeled to determine the important design parameters that influence the pressure fluctuation in the liquid ring during a complete engine cycle and the integrity of the liquid ring. This analysis indicated the importance of controlling heat transfer to the liquid ring through piston and liner to avoid boiling the liquid. A conceptual piston design for minimizing heat transfer is presented in this report. Results showed that the liquid piston ring effectively reduced the solid particles on the wall by scrubbing, especially in the case where a surfactant was added to the water. The wear rates were reduced by a factor of 2 with the liquid ring. However, leakage of the contaminated liquid ring material past the top ring limited the effectiveness of the liquid ring concept. DOE

N91-24335*# Calspan-Buffalo Univ. Research Center, NY.
HEAT-TRANSFER AND SURFACE-PRESSURE MEASUREMENTS FOR THE SSME FUEL-SIDE TURBOPUMP TURBINE
Michael G. Dunn *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 215-222 (For primary document see N91-24307 16-20)
(Grant NAG3-581)
Avail: NTIS HC/MF A12 CSCL 13I

N91-24605*# Spar Aerospace Ltd., Toronto (Ontario). Advanced Technological Systems Group.
SYSTEM REQUIREMENTS AND DESIGN FEATURES OF SPACE STATION REMOTE MANIPULATOR SYSTEM MECHANISMS
Rajnish Kumar and Robert Hayes *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 15-30 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24608*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
BRAKE LOCK MECHANISM FOR THE TWO AXIS POINTING SYSTEM
Alan Posey, Mike Clark, and Larry Mignosa (Swales and Associates, Beltsville, MD.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 61-75 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24609*# Tsukuba Space Center, Ibaragi (Japan).
AN ANTENNA-POINTING MECHANISM FOR THE ETS-6 K-BAND SINGLE ACCESS (KSA) ANTENNA
Noboru Takada, Takahiro Amano, Toshiro Ohhashi, and Shigeo Wachi (Toshiba Corp., Kanagawa, Japan) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 77-92 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24611*# Ball Corp., Boulder, CO. Electro-Optics/Cryogenics Div.
SIRTF/IRS CRYOGENIC GRATING DRIVE MECHANISM (ARC SECOND POSITIONING AT 4 K)
Michael J. Kubitschek *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 107-124 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24612*# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
DEVELOPMENT OF A RELATCHABLE COVER MECHANISM FOR A CRYOGENIC IR-SENSOR
R. Birner, G. Lange, M. Roth, and A. Voit *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 125-134 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24613*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
A SYNCHRONOUS CHOPPER MECHANISM FOR USE AT CRYOGENIC TEMPERATURE
Claef Hakun, Allen Tyler, and Cornelis deKramer *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 135-150 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24614*# Mullard Space Science Lab., Dorking (England).
CRYOGENIC MECHANISMS FOR SCANNING AND INTERCHANGE OF THE FABRY-PEROT INTERFEROMETERS IN THE ISO LONG WAVELENGTH SPECTROMETER
G. R. Davis, I. Furniss, T. J. Patrick, R. C. Sidey, and W. A. Towlson (University Coll., London, England) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 151-159 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24615*# Lockheed Missiles and Space Co., Sunnyvale, CA.
SPIN BEARING RETAINER DESIGN OPTIMIZATION
Edward A. Boesiger and Mark H. Warner (Honeywell, Inc., Glendale, AZ.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 161-178 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24616*# Toshiba Corp., Kawasaki (Japan).
WEAR CHARACTERISTICS OF BONDED SOLID FILM LUBRICANT UNDER HIGH LOAD CONDITION
Naofumi Hiraoka, Akira Sasaki, Noritsugu Kawashima, and Toshio Honda *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 179-193 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24617*# Nissan Motor Co. Ltd., Tokyo (Japan). Aerospace Div.
DEVELOPMENT OF SOLID-LUBRICATED BALL-SCREWS FOR USE IN SPACE
Masatoshi Chiba, Toru Gyougi, Makoto Nishimura, and Katsumi Seki (National Aerospace Lab., Tokyo, Japan) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 195-204 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24618*# Honeywell, Inc., Glendale, AZ. Satellites Systems Operations.
TOPEX HIGH-GAIN ANTENNA SYSTEM DEPLOYMENT ACTUATOR MECHANISM
Stephen R. Jones *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 205-220 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24619*# Starsys Research Corp., Boulder, CO.
RESETTABLE BINARY LATCH MECHANISM FOR USE WITH PARAFFIN LINEAR MOTORS
Daryl Maus and Scott Tibbitts *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 221-236 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24620*# TRW Space Technology Labs., Redondo Beach, CA.
HARMONIC DRIVE GEAR ERROR: CHARACTERIZATION AND COMPENSATION FOR PRECISION POINTING AND TRACKING
Ted W. Nye and Robert P. Kraml *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 237-252 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24622*# Contraves Italiana, Rome.
SMA APPLICATIONS IN AN INNOVATIVE MULTISHOT DEPLOYMENT MECHANISM
D. Stella, G. Pedrazzoli, G. Secci, and C. Portelli (Italian Space Agency, Rome.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 275-290 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-24625*# Honeywell, Inc., Minneapolis, MN. Systems and Control Sciences Dept.
A NEW ACTIVE VIRTUAL PIVOT SIX-DEGREE-OF-FREEDOM HAND CONTROLLER FOR AEROSPACE APPLICATIONS
William C. Marshall, Kathleen M. Radke, Robert E. DeMers, David J. Lowry, and Lee Levitan *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 323-337 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

N91-25086*# Boeing Aerospace and Electronics Co., Seattle, WA.
LDEF MECHANICAL SYSTEMS Abstract Only
Steve Spear and Harry Dursch *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 120 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 13I

N91-25087*# Boeing Aerospace and Electronics Co., Seattle, WA.
ON-ORBIT COLDWELDING Abstract Only
Harry Dursch and Steve Spear *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 121 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 13I

N91-25091*# Aerospatiale, Cannes (France).
MICROWELDING OF VARIOUS METALLIC MATERIALS UNDER ULTRAVACUUM (AO 138-10) Abstract Only
Jean Pierre Assie and Eric Conde (Centre National d'Etudes Spatiales, Toulouse, France) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 125 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 13I

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

N91-24596# Forest Service, Washington, DC.
FROM THE PILOT TEST PHILOSOPHY TO TOTAL QUALITY MANAGEMENT: A LOGICAL PROGRESSION, A MANAGER'S GUIDE Final Report
B. DeLaney May 1990 15 p
(PB91-155168) Avail: NTIS HC/MF A03 CSCL 14D

A guide written to explore the relationship between the Forest Service's management philosophy of the National Pilot Test Initiative and total quality management is presented. Additionally, the guide presents some ideas and suggestions for building on past Forest Service successes, and on linking the above management approaches together. GRA

N91-24597# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
THERMOELECTRIC POTENTIAL EFFECT AND ITS APPLICATIONS IN NONDESTRUCTIVE TESTING
Kebei Xu 7 Nov. 1990 12 p Transl. into ENGLISH from Wunsun Jiance (Peoples Rep. of China), v. 11, no. 12 1989 p 335; 339-340
(AD-A233048; FTD-ID(RS)T-0536-90) Avail: NTIS HC/MF A03 CSCL 14/2

The paper presents the principle of the thermoelectric potential and applications of a thermoelectric potential sorting instrument. The thermoelectric effect is one of the basic phenomena exhibited by metallic materials. The effect exhibits a reversible process of electrons subjected to external electricity and heat. This process is related to many physical quantities, especially factors relating to electroconductivity and thermoconductivity of metallic materials, such as material properties, alloys constituents, as well as metallographic textures and structures. There are mainly three effects of the thermoelectric potential: Seebeck effect, Peltier effect, and Thomson effect. In this paper, the author presents only the Seebeck effect, which is the effect most closely related to thermoelectric potential sorting. GRA

N91-24598# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Technology Div.
NONDESTRUCTIVE TESTING (SELECTED ARTICLES)
19 Mar. 1991 105 p Transl. into ENGLISH from Wusun Jiance (China), v. 11, no. 5, 1989 p 121-147
(AD-A233424; FTD-ID(RS)T-0356-90) Avail: NTIS HC/MF A06 CSCL 14/2

Articles on the following are presented: (1) effect of compensation on ultrasonic inspection of pipe welds; (2) control of K value for radiographic inspection of welded joints; (3) identification and investigation of incomplete fusion of welds on radiographs; (4) new method of nondestructive testing of internal stresses -- magnetic acoustic emission; (5) discussion on film assessment of weld roots in pad welding; (6) rules for qualification and certification of nondestructive tests personnel -- Chinese People's Republic State Standard GB 9445-88. GRA

N91-24599*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AN EVALUATION OF THE TOTAL QUALITY MANAGEMENT IMPLEMENTATION STRATEGY FOR THE ADVANCED SOLID ROCKET MOTOR PROJECT AT NASA'S MARSHALL SPACE FLIGHT CENTER M.S. Thesis - Tennessee Univ.
Harry F. Schramm and Kenneth W. Sullivan May 1991 120 p (NASA-TM-103533; NAS 1.15:103533) Avail: NTIS HC/MF A06 CSCL 14D

An evaluation of the NASA's Marshall Space Flight Center (MSFC) strategy to implement Total Quality Management (TQM) in the Advanced Solid Rocket Motor (ASRM) Project is presented. The evaluation of the implementation strategy reflected the Civil Service personnel perspective at the project level. The external and internal environments at MSFC were analyzed for their effects on the ASRM TQM strategy. Organizational forms, cultures, management systems, problem solving techniques, and training were assessed for their influence on the implementation strategy. The influence of ASRM's effort was assessed relative to its impact on mature projects as well as future projects at MSFC. Author

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

N91-24600 Brown Univ., Providence, RI.
A CLASS OF CONCURRENT ALGORITHMS FOR TRANSIENT FINITE ELEMENT ANALYSIS Ph.D. Thesis
Elisa Dominguez Sotelino 1990 107 p
Avail: Univ. Microfilms Order DA9101836

The advent of parallel computers with multiprocessing capabilities offers exciting possibilities for the development of new computational algorithms. Considerable research is underway to replace the traditional algorithms devised for sequential machines by others well suited to parallel computing. The development of parallel algorithms is examined in the area of structural dynamics. Following a succinct summary, some features of the new computer architectures which bear on subsequent discussions, and a brief overview of current research efforts in the area, a new class of concurrent procedures, or Group Implicit (GI) algorithms, is introduced and analyzed. In essence, these algorithms are constructed by partitioning the finite element mesh into groups of elements, and processing each group implicitly and independently over a time step. This last feature introduces the desired concurrency into the computations. The requisite compatibility between the subdomains is enforced a-posteriori, by means of a mass averaging rule. It is shown that the resulting algorithms have ranges of unconditional stability similar to those of globally implicit methods. Guidelines are given for choosing the time steps so that accuracy does not deteriorate as the number of element groups is increased. Numerical simulations as well as theoretical derivations show that the appeal of GI algorithms is twofold. Firstly, they are highly parallelizable, with interprocessor communications limited to the exchange of one interface vector per time step. Secondly, they speed up the computations by reducing the equation solving effort, even on a single-processor machine.
Dissert. Abstr.

N91-24601 Brown Univ., Providence, RI.
AMBIENT AND ELEVATED TEMPERATURE FATIGUE CRACK GROWTH IN ALUMINA Ph.D. Thesis
Lynn M. Ewart 1990 216 p
Avail: Univ. Microfilms Order No. DA9101763

The existence was established of fatigue in ceramic materials

at ambient and elevated temperatures and its mechanism elucidated. It is shown that at room temperature stable mode I cracks can be induced at the tip of a notch subject to far field cyclic compressive loads. In contrast, stable mode I cracks do not grow under static compressive loads comparable in magnitude to the peak cyclic loads which cause crack growth. Fatigue crack growth is observed only in polycrystalline brittle solids. Debris particles form between the crack faces and contribute to crack closure. Studies in cubic magnesia reveal that residual thermal stresses are not the primary cause of the damage which leads to crack growth. Stable cracks propagate in ceramics despite the lack of dislocation motion. Both room and high temperature crack grow by nucleation and coalescence of grain boundary microcracks. At high temperatures cavitation also occurs. The reason for the crack growth is that nonlinearity in the stress-strain curve, in this case due to microcracking and interfacial cavitation, may lead to kinematically irreversible damage and can cause permanent strains which will lead to the development of zones of residual stresses.
Dissert. Abstr.

N91-24602 Brown Univ., Providence, RI.
ELEVATED TEMPERATURE CRACK GROWTH RESISTANCE OF ALUMINA-SILICON-CARBIDE COMPOSITE UNDER STATIC AND CYCLIC LOADS Ph.D. Thesis
Xiaohua Han 1990 146 p
Avail: Univ. Microfilms Order No. DA9101771

The crack growth behavior in ceramic composites was studied. The study showed that permanent fatigue damage and stable crack growth in cyclic compression can occur in Si3N4-SiC(w) composites at room temperature. The principal mechanisms of the failure are discussed. During compressive stress, extensive inelastic deformation is induced in the vicinity of the notch root. If this deformation leaves permanent strain, upon unloading from the compressive stress, a residual tensile stress zone is created at the notch-tip. When the tensile stress exceeds the strength of the material, Mode 1 fatigue crack growth occurs. It was also shown that stable high temperature crack propagation can occur in Al2O3-SiC(w) under both static and cyclic tensile loads at stress intensity values far below the fracture toughness. The origin of permanent inelastic deformation and creep fatigue crack growth appears to be interfacial and intergranular cavitation produce pronounced microcracking in the composite. This cavitation mechanism is promoted by the oxidation of SiC whiskers in the high temperature air environment, leading to the formation and viscous flow of an SiO2 glassy phase along the SiC-Al2O3 interface. Cyclic fatigue behavior needs study. Dissert. Abstr.

N91-24603*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE 25TH AEROSPACE MECHANISMS SYMPOSIUM
May 1991 346 p Symposium held in Pasadena, CA, 8-10 May 1991; sponsored by NASA, Washington, California Inst. of Tech., and LMSC
(Contract NAS7-918)
(NASA-CP-3113; NAS 1.55:3113) Avail: NTIS HC/MF A15 CSCL 20K

Twenty-two papers are documented regarding aeronautical and spacecraft hardware. Technological areas include actuators, latches, cryogenic mechanisms, vacuum tribology, bearings, robotics, ground support equipment for aerospace applications, and other mechanisms. For individual titles, see N91-24604 through N91-24625.

N91-24604*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CETA TRUCK AND EVA RESTRAINT SYSTEM **c54**
David C. Beals and Wayne R. Merson (Lockheed Engineering and Sciences Co., Hampton, VA.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 1-14 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 05H

The Crew Equipment Translation Aid (CETA) experiment is an extravehicular activity (EVA) Space Transportation System (STS) based flight experiment which will explore various modes of transporting astronauts and light equipment for Space Station Freedom (SSF). The basic elements of CETA are: (1) two 25 foot long sections of monorail, which will be EVA assembled in the STS cargo bay to become a single 50 ft. rail called the track; (2) a wheeled baseplate called the truck which rolls along the track and can accept three cart concepts; and (3) the three carts which are designated manual, electric, and mechanical. The three carts serve as the astronaut restraint and locomotive interfaces with the track. The manual cart is powered by the astronaut grasping the track's handrail and pulling himself along. The electric cart is operated by an astronaut turning a generator which powers the electric motor and drives the cart. The mechanical cart is driven by a Bendix type transmission and is similar in concept to a man-propelled railroad cart. During launch and landing, the truck is attached to the deployable track by means of EVA removable restraint bolts and held in position by a system of retractable shims. These shims are positioned on the exterior of the rail for launch and landing and rotate out of the way for the duration of the experiment. The shims are held in position by strips of Velcro nap, which rub against the sides of the shim and exert a tailored force. The amount of force required to rotate the shims was a major EVA concern, along with operational repeatability and extreme temperature effects. The restraint system was tested in a thermal-vac and vibration environment and was shown to meet all of the initial design requirements. Using design inputs from the astronauts who will perform the EVA, CETA evolved through an iterative design process and represented a cooperative effort.
Author

N91-24605*# Spar Aerospace Ltd., Toronto (Ontario). Advanced Technological Systems Group.
SYSTEM REQUIREMENTS AND DESIGN FEATURES OF SPACE STATION REMOTE MANIPULATOR SYSTEM MECHANISMS **c37**
Rajnish Kumar and Robert Hayes *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 15-30 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

The Space Station Remote Manipulator System (SSRMS) is a long robotic arm for handling large objects/payloads on the International Space Station Freedom. The mechanical components of the SSRMS include seven joints, two latching end effectors (LEEs), and two boom assemblies. The joints and LEEs are complex aerospace mechanisms. The system requirements and design features of these mechanisms are presented. All seven joints of the SSRMS have identical functional performance. The two LEES are identical. This feature allows either end of the SSRMS to be used as tip or base. As compared to the end effector of the Shuttle Remote Manipulator System, the LEE has a latch and umbilical mechanism in addition to the snare and rigidize mechanisms. The latches increase the interface preload and allow large payloads (up to 116,000 Kg) to be handled. The umbilical connectors provide power, data, and video signal transfer capability to/from the SSRMS.
Author

N91-24606*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
DEAD-BLOW HAMMER DESIGN APPLIED TO A CALIBRATION TARGET MECHANISM TO DAMPEN EXCESSIVE REBOUND **c19**
Brian Y. Lim *In its* The 25th Aerospace Mechanisms Symposium May 1991 p 31-44 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 14B

An existing rotary electromagnetic driver was specified to be used to deploy and restow a blackbody calibration target inside of a spacecraft infrared science instrument. However, this target was much more massive than any other previously inherited design applications. The target experienced unacceptable bounce when reaching its stops. Without any design modification, the momentum generated by the driver caused the target to bounce back to its starting position. Initially, elastomeric dampers were used between

the driver and the target. However, this design could not prevent the bounce, and it compromised the positional accuracy of the calibration target. A design that successfully met all the requirements incorporated a sealed pocket 85 percent full of 0.75 mm diameter stainless steel balls in the back of the target to provide the effect of a dead-blow hammer. The energy dissipation resulting from the collision of balls in the pocket successfully dampened the excess momentum generated during the target deployment. The disastrous effects of new requirements on a design with a successful flight history, the modifications that were necessary to make the device work, and the tests performed to verify its functionality are described. Author

N91-24607*# General Dynamics Corp., San Diego, CA. Space Systems Div.

DESIGN AND DEVELOPMENT OF THE REDUNDANT LAUNCHER STABILIZATION SYSTEM FOR THE ATLAS 2 LAUNCH VEHICLE **c15**

M. Nakamura *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 45-60 (For primary document see N91-24603 16-39)

Avail: NTIS HC/MF A15 CSCL 22B

The Launcher Stabilization System (LSS) is a pneumatic/hydraulic ground system used to support an Atlas launch vehicle prior to launch. The redesign and development activity undertaken to achieve an LSS with increased load capacity and a redundant hydraulic system for the Atlas 2 launch vehicle are described. Author

N91-24608*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

BRAKE LOCK MECHANISM FOR THE TWO AXIS POINTING SYSTEM **c37**

Alan Posey, Mike Clark, and Larry Mignosa (Swales and Associates, Beltsville, MD.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 61-75 (For primary document see N91-24603 16-39)

Avail: NTIS HC/MF A15 CSCL 13I

Six months prior to shipment of the Broadband X-ray Telescope to the Kennedy Space Center for flight aboard the Space Shuttle Columbia, a major system failure occurred. During modal survey testing of the telescope's gimbal pointing system, the roll axis brake unexpectedly released. Low level vibration and static preloads present during the modal survey were within the expected flight environment. Brake release during shuttle liftoff or ascent was an unacceptable risk to mission success; thus, a Brake Lock Mechanism (BLM) was developed. Author

N91-24609*# Tsukuba Space Center, Ibaragi (Japan).

AN ANTENNA-POINTING MECHANISM FOR THE ETS-6 K-BAND SINGLE ACCESS (KSA) ANTENNA **c37**

Noboru Takada, Takahiro Amano, Toshiro Ohhashi, and Shigeo Wachi (Toshiba Corp., Kanagawa, Japan) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 77-92 (For primary document see N91-24603 16-39)

Avail: NTIS HC/MF A15 CSCL 13I

Both the design philosophy for the Antenna Pointing Mechanism (APM) to be used for the K-band Single Access (KSA) antenna system and experimental results of the APM Engineering Model (EM) tests are described. The KSA antenna system will be flown on the Engineering Test Satellite 6 (ETS-6). Author

N91-24610*# Ball Corp., Boulder, CO. Electro-Optics/Cryogenics Div.

POINTING/ROLL MECHANISM FOR THE ULTRAVIOLET CORONAGRAPH SPECTROMETER **c19**

Miroslaw A. Ostaszewski and Larry J. Guy *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 93-105 (For primary document see N91-24603 16-39)

Avail: NTIS HC/MF A15 CSCL 14B

A pointing/roll mechanism for the Ultraviolet Coronagraph Spectrometer (UVCS) is presented along with a description of the mechanism control algorithm. The mechanism, operating in space, will position the 2.1 meter long, 0.7 meter diameter UVCS instrument in pitch and yaw, within a 54 arc-minute half angle cone, and will also allow it to rotate + or - 179.75 deg. After considerable design effort, an optimum mechanical solution was achieved, which meets all scientific requirements as well as weight, volume, and power budgets. Evolution of the mechanism is presented along with the design status. Author

N91-24611*# Ball Corp., Boulder, CO. Electro-Optics/Cryogenics Div.

SIRTF/IRS CRYOGENIC GRATING DRIVE MECHANISM (ARC SECOND POSITIONING AT 4 K) **c37**

Michael J. Kubitschek *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 107-124 (For primary document see N91-24603 16-39)

Avail: NTIS HC/MF A15 CSCL 13I

The requirements, design, and test results of a grating drive mechanism for the Infrared Spectrograph (IRS) science instrument on the proposed superfluid helium-cooled Space Infrared Telescope Facility (SIRTF) are described. The IRS grating drive mechanism, tested in the fall of 1989, satisfied all performance requirements in vacuum at 4 K. Measured mechanism performance included: 1.4 arc sec root-mean-square (rms) error positioning resolution; 2.2 arc sec rms position repeatability error, less than 10 millijoules/deg dissipated power; and 170 deg angular range of travel. Mechanisms that precisely position optical elements at very low cryogenic temperatures (at/below 4 K) are vital to the operating success of a number of proposed infrared scientific instruments like those in SIRTF. Author

N91-24612*# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).

DEVELOPMENT OF A RELATCHABLE COVER MECHANISM FOR A CRYOGENIC IR-SENSOR **c37**

R. Birner, G. Lange, M. Roth, and A. Voit *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 125-134 (For primary document see N91-24603 16-39)

Avail: NTIS HC/MF A15 CSCL 13I

A cover mechanism for use on the Infrared Background Signature Survey (IBSS) cryostat was developed. The IBSS IR-instrument is scheduled for STS launch in early 1991 as a payload of the Shuttle Payload Satellite (SPS) 2. The cover is hinged, with a motorized rope drive. During ground processing, launch, entry, and landing, the cryostat, which houses the IR-instrument, is required to be a sealed vacuum tight container for cooling purposes and contamination prevention. When on orbit, the cover is opened to provide an unobstructed field of view for the IR-instrument. A positive seal is accomplished through the use of latch mechanism. The cover and the latch are driven by a common redundant actuator consisting of dc motors, spur gears, and a differential gear. Hall probe limit switches and position sensors (rotary variable transformer) are used to determine the position of the cover and the latch. The cover mechanism was successfully qualified for thermal vacuum (-25 to 35 C), acoustic noise, vibration (6 Gs sine, 9.7 G RMS) and life cycles. Constricting requirements, mechanical and electronic control design, specific design details, test results of functional performance, and environmental and life tests are described. Author

N91-24613*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

A SYNCHRONOUS CHOPPER MECHANISM FOR USE AT CRYOGENIC TEMPERATURE **c37**

Claef Hakun, Allen Tyler, and Cornelis deKramer *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 135-150 (For primary document see N91-24603 16-39)

Avail: NTIS HC/MF A15 CSCL 13I

A mechanically resonant synchronous chopper mechanism is described for use at cryogenic temperatures. The mechanism is a critical optical component of the Diffuse Infrared Background Experiment (DIRBE) and has been operating on orbit without incident since Nov. 1989. The requirements, electromechanical design, and testing of the mechanism are described. A description

of the problems encountered and solutions implemented during the development of the mechanism is provided. Finally, a modified chopper design, which incorporated lessons learned and that has several advantages over the flight chopper design, is offered.
Author

N91-24614*# Mullard Space Science Lab., Dorking (England).
CRYOGENIC MECHANISMS FOR SCANNING AND INTERCHANGE OF THE FABRY-PEROT INTERFEROMETERS IN THE ISO LONG WAVELENGTH SPECTROMETER **c37**
G. R. Davis, I. Furniss, T. J. Patrick, R. C. Sidey, and W. A. Towlson (University Coll., London, England) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 151-159 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

The Infrared Space Observatory (ISO) is an ESA cornerstone mission for infrared astronomy. Schedules for launch in 1993, its four scientific instruments will provide unprecedented sensitivity and spectral resolution at wavelengths which are inaccessible using ground-based techniques. One of these, the Long Wavelength Spectrometer (LWS), will operate in the 45 to 180 micron region (Emery et. al., 1985) and features two Fabry-Perot interferometers mounted on an interchange mechanism. The entire payload module of the spacecraft, comprising the 60 cm telescope and the four focal plane instruments, is maintained at 2 to 4 K by an onboard supply of liquid helium. The mechanical design and testing of the cryogenic interferometer and interchange mechanisms are described.
Author

N91-24615*# Lockheed Missiles and Space Co., Sunnyvale, CA.
SPIN BEARING RETAINER DESIGN OPTIMIZATION **c37**
Edward A. Boesiger and Mark H. Warner (Honeywell, Inc., Glendale, AZ.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 161-178 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

The dynamics behavior of spin bearings for momentum wheels (control-moment gyroscope, reaction wheel assembly) is critical to satellite stability and life. Repeated bearing retainer instabilities hasten lubricant deterioration and can lead to premature bearing failure and/or unacceptable vibration. These instabilities are typically distinguished by increases in torque, temperature, audible noise, and vibration induced by increases into the bearing cartridge. Ball retainer design can be optimized to minimize these occurrences. A retainer was designed using a previously successful smaller retainer as an example. Analytical methods were then employed to predict its behavior and optimize its configuration.
Author

N91-24616*# Toshiba Corp., Kawasaki (Japan).
WEAR CHARACTERISTICS OF BONDED SOLID FILM LUBRICANT UNDER HIGH LOAD CONDITION **c37**
Naofumi Hiraoka, Akira Sasaki, Noritsugu Kawashima, and Toshio Honda *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 179-193 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

Wear properties of phenolic resin bonded molybdenum disulfide film lubricant were studied. In-vacuo journal bearing tests were performed to evaluate the wear-life of this film lubricant. The wear-life depends on substrate materials and on sliding velocity. Pretreated substrate surfaces were examined to reveal the reasons for these results. Additionally, investigations on film wear mechanisms were made.
Author

N91-24617*# Nissan Motor Co. Ltd., Tokyo (Japan). Aerospace Div.
DEVELOPMENT OF SOLID-LUBRICATED BALL-SCREWS FOR USE IN SPACE **c37**
Masatoshi Chiba, Toru Gyougi, Makoto Nishimura, and Katsumi Seki (National Aerospace Lab., Tokyo, Japan) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 195-204 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

Ball-screws lubricated by solid lubricant films containing molybdenum disulphide are developed. The ball-screws (shaft diameter: phi 25 mm, length: 667 mm) were operated under a load of 40 to 120 N at a speed of 1.5 to 200 rpm at 10(exp -5) Pa. First, ball-screws made of stainless steel SUS 440C were studied using test equipment originally designed for this study. To reduce weight, the next step taken was to develop a ball-screw made of 6Al-4V-titanium. Long wear-life of more than 1 x 10(exp 7) revolutions was achieved with solid lubricated ball-screws made of SUS 440C and 6Al-4V-titanium in a hard vacuum. According to the surface profile of the shaft measured after 1 x 10(exp 7) revolutions, more solid lubricant remained on the surface of 6Al-4V-titanium than that of stainless steel. Auger and EPMA analysis confirmed lubrication was maintained by solid lubricant on nuts and screws after the lubricant films on the balls were worn off.
Author

N91-24618*# Honeywell, Inc., Glendale, AZ. Satellites Systems Operations.
TOPEX HIGH-GAIN ANTENNA SYSTEM DEPLOYMENT ACTUATOR MECHANISM **c37**
Stephen R. Jones *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 205-220 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

A deployment actuator mechanism was developed to drive a two-axis gimbal assembly and a high-gain antenna to a deployed and locked position on the Jet Propulsion Laboratory Ocean Topography Experiment (TOPEX) satellite. The Deployment Actuator Mechanism requirements, design, test, and associated problems and their solutions are discussed.
Author

N91-24619*# Starsys Research Corp., Boulder, CO.
RESETTABLE BINARY LATCH MECHANISM FOR USE WITH PARAFFIN LINEAR MOTORS **c37**
Daryl Maus and Scott Tibbitts *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 221-236 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

A new resettable Binary Latch Mechanism was developed utilizing a paraffin actuator as the motor. This linear actuator alternately latches between extended and retracted positions, maintaining either position with zero power consumption. The design evolution and kinematics of the latch mechanism are presented, as well as the development problems and lessons that were learned.
Author

N91-24620*# TRW Space Technology Labs., Redondo Beach, CA.
HARMONIC DRIVE GEAR ERROR: CHARACTERIZATION AND COMPENSATION FOR PRECISION POINTING AND TRACKING **c37**
Ted W. Nye and Robert P. Kraml *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 237-252 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

Imperfections and geometry effects in harmonic drive gear reducers cause a cyclic gear error, which at a systems level, results in high frequency torque fluctuations. To address this problem, gear error testing was performed on a wide variety of sizes and types of harmonic drives. It was found that although all harmonic drives exhibit a significant first harmonic, higher harmonics varied greatly with each unit. From life tests, small changes were found in harmonic content, phase shift, and error magnitude (on the order of .008 deg peak-to-peak maximum) occurred for drives with many millions of degrees of output travel. Temperature variations also influenced gear error. Over a spread of approximately 56 C (100 F), the error varied in magnitude approximately 20 percent but changes in a repeatable and predictable manner. Concentricity and parallelness tests of

harmonic drive parts resulted in showing alignment influence gear error amplitude. Tests on dedoidaled harmonic drives showed little effect on gear error; surprisingly, in one case for a small drive, gear error actually improved. Electronic compensation of gear error in harmonic drives was shown to be substantially effective for units that are first harmonic dominant. Author

N91-24621*# Honeywell, Inc., Glendale, AZ. Satellite Systems Operations.
PAYLOAD SPIN ASSEMBLY FOR THE COMMERCIAL TITAN LAUNCH VEHICLE c15
Wilf Robinson and Greg Pech (Martin Marietta Corp., Denver, CO.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 253-274 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 22B

A contract was completed to design, build, and test a Payload Spin Assembly (PSA) for installation onto the Martin Marietta Titan 3 Commercial launch vehicle. This assembly provides launch support for satellite payloads up to 5783 kilograms (6.37 tons) and controls release, spin-up, and final separation of the satellite from the second stage. Once separated, the satellite's Perigee Kick Motor (PKM) boosts the satellite into its transfer orbit. The first successful flight occurred December 31, 1989. Requirements, design, test, and problems associated with this mechanical assembly are discussed. Author

N91-24622*# Contraves Italiana, Rome.
SMA APPLICATIONS IN AN INNOVATIVE MULTISHOT DEPLOYMENT MECHANISM c37
D. Stella, G. Pedrazzoli, G. Secci, and C. Portelli (Italian Space Agency, Rome.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 275-290 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

An innovative Deployment and Retraction hinge Mechanism (DARM) in the frame of a technological program is examined. The mechanism includes two restraint/release devices, which enable it to be stable in its stowed or deployed position while sustaining all associated loads, and to carry its payload by remote command. The main characteristics of the DARM are as follows: deployment and retraction movements are spring actuated; the available amount of functional sequences is almost unlimited; and no use of electrical motors is made. These features were accomplished by: the application of a special kinematic scheme to the mechanical connection between the spring motor and the swivel head arm; and the use of shape memory alloys (SMA) actuators for both release and spring recharge functions. DARM is thus a mechanism which can find many applications in the general space scenario of in-orbit maintenance and servicing. In such a frame, the DARM typical concept, which has a design close to very simple one-shot deployment mechanisms, has a good chance to replace existing analog machines. Potential items that could be moved by DARM are: booms for satellite instruments; antenna reflector tips; entire antenna reflectors; and solar panels. Author

N91-24623*# Lockheed Space Operations Co., Cocoa Beach, FL.
SPACE SHUTTLE HOLDDOWN POST BLAST SHIELD c14
F. B. Larracas *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 291-306 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 09B

The original and subsequent designs of the Solid Rocket Booster/Holddown Post blast shield assemblies and their associated hardware are described. It presents the major problems encountered during their early use in the Space Shuttle Program, during the Return-to-Flight Modification Phase, and during their fabrication and validation testing phases. The actions taken to correct the problems are discussed, along with the various concepts now being considered to increase the useful life of the blast shield. Author

N91-24624*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE DYNAMIC TORQUE CALIBRATION UNIT: AN INSTRUMENT FOR THE CHARACTERIZATION OF BEARINGS USED IN GIMBAL APPLICATIONS c35
Louise Jandura *In its* The 25th Aerospace Mechanisms Symposium May 1991 p 307-322 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 14B

The Dynamic Torque Calibration Unit (DTCU), an instrument for the characterization of duplex ball bearing pairs used in gimbal applications, was designed and built. The design and operation of the unit are described. Preliminary data from the instrument are presented to illustrate the kinds of experiments that can be performed with the DTCU. Author

N91-24625*# Honeywell, Inc., Minneapolis, MN. Systems and Control Sciences Dept.
A NEW ACTIVE VIRTUAL PIVOT SIX-DEGREE-OF-FREEDOM HAND CONTROLLER FOR AEROSPACE APPLICATIONS c37
William C. Marshall, Kathleen M. Radke, Robert E. DeMers, David J. Lowry, and Lee Levitan *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 323-337 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 13I

During 1989 a new six-degree-of-freedom (6-DOF) active hand controller concept was designed and constructed based on the concept of a virtual pivot. This concept, labeled VPHC, was first demonstrated in a 1985 study and a patent was issued in 1990. Operator control input occurs via a force/torque sensor rigidly mounted to the handgrip. Sensed force/torque signals are used by microprocessors to generate motor drive control for each of six independently controlled motors mounted on the three-legged mechanism. The control microprocessor uses input biasing and rate-feedback motor controllers to generate the sensed feel of virtual springs and deadbands found in more conventional designs. An important advantage of this design is that the location of the virtual pivots, reflective forces and torques, breakout force levels, sensed spring rates, and operating modes, can be changed simply by changing the software. This approach yields an autonomous VPHC that can easily adapt itself to an individual operator (by software extension). A proof-of-concept version has been demonstrated, and further improvements are currently being studied and implemented. Author

N91-24626 Virginia Polytechnic Inst. and State Univ., Blacksburg.
ACTIVE VIBRATION CONTROL OF COMPOSITE STRUCTURES Ph.D. Thesis
Min-Yung Chang 1990 289 p
Avail: Univ. Microfilms Order No. DA9103512

The vibration control of composite beams and plates subjected to a traveling load is studied. By comparing the controlled and uncontrolled responses of classical and refined structural models, the influence of important composite structure properties which are not included in the classical structural model is revealed. The modal control approach is used to suppress the structural vibration. In modal control, the control is effected by controlling the modes of the system. The control law is obtained by using the optimal control theory. Comparison of two variants of the modal control approach, the coupled modal control (CMC) and independent modal space control (IMSC), is made. The results are found to be in agreement with those obtained by others. It is found that, when performing the structural analysis control system design for a composite structure, the classical structural models (such as the Euler-Bernoulli beam and Kirchhoff plate) yield erroneous conclusions concerning the performance of the actual structural system. Transverse shear deformation, anisotropy, damping, and the parameters associated with the traveling load are shown to have great influence on structural responses. Dissert. Abstr.

N91-24627 Illinois Univ., Chicago.
STRESS DISTRIBUTION AT A THREE-DIMENSIONAL SINGULARITY IN ANISOTROPIC MATERIALS AND COMPOSITES Ph.D. Thesis
Phuong Huy Hoang 1990 124 p
Avail: Univ. Microfilms Order No. DA9104461

Three dimensional stress distribution at singular points in anisotropic and composite materials are presented. A general finite element scheme based on a variational principle is used to find the eigenvalues and the corresponding stress distribution function for various shapes of singular points. The shape of a cross section at a constant radius from the apex of a conical wedge defines the geometry of a singular point. The method can be applied for any shape. Numerical examples are given for a 3-D crack and a right angle pyramidal notch. The stress distribution function is plotted on a sphere like surface. Results of a test problem for isotropic material show a good agreement with available analytical and semianalytical solutions. For further applications, 3-D stress distributions at the crack tip of an interface crack and a transverse crack in isotropic bimaterials, in anisotropic materials and composites are presented. Notch stress singularities in anisotropic materials are also discussed. The singularity solutions presented here can be used as a special element at the singular point and regular finite elements are used elsewhere. Dissert. Abstr.

N91-24628 Missouri Univ., Rolla.
FINITE AND BOUNDARY ELEMENT ANALYSIS OF THREE-DIMENSIONAL LINEAR ELASTOSTATICS Ph.D. Thesis
Amir H. Yahyavi 1990 82 p
Avail: Univ. Microfilms Order No. DA9032116

A combined Finite Element and Boundary Element Method is presented to calculate displacements and stresses in 3-D linearly elastic materials. The Finite Element Method (FEM) is a very powerful and reliable numerical method of solving elasticity problems, but in a 3-D domain, preparation of data for analysis can become a hard task, integration over the domain is time consuming, and mesh refinement is required in regions with high stress gradient in order to obtain meaningful results. On the other hand, the Boundary Element Method (BEM) is a numerical method which reduces the dimension of the problem. The discretization of the body and, consequently, the calculations are done on the boundaries. There is no postprocessor required in this method to solve for additional unknowns on the boundaries. The only shortcoming of this method is that, unlike the FEM which has a stiffness matrix that is symmetric and banded, the BEM matrices are not symmetric and are full. A combined FEM and BEM method overcomes these problems by not forming the full BEM matrices. The FEM was used to solve for the unknowns using a coarse mesh and the boundary integral equations were calculated for additional nodes added as the mesh is refined. Dissert. Abstr.

N91-24629 Purdue Univ., West Lafayette, IN.
A GLOBAL-LOCAL STRUCTURAL ANALYSIS METHOD Ph.D. Thesis
Kunming Mao 1990 150 p
Avail: Univ. Microfilms Order No. DA9104669

A global-local method is proposed in order to effectively analyze structural problems that may result in a large system of equations. It is accomplished in two steps, i.e., the global analysis and the local analysis. In the global analysis, the regular finite element model, in conjunction with a global coarse mesh, is used to produce a global displacement. Then the local analysis is conducted to analyze detailed stresses in small local regions. In the local analysis, the original large structure is decomposed into many small ones. Besides, parallel computation can easily be introduced in the global-local method. Further development of the global-local method is made by introducing its refined version, i.e., the refined global-local method. Basically the refined global-local method contains one more step of global computation. Examples have shown that it can produce nearly the same accuracy as the regular finite element method with less computing time. Applications of the global-local methods to elastic-plastic problems as well as error analysis clearly demonstrate their great potential to solve a wide range of problems. Dissert. Abstr.

N91-24630 Ohio State Univ., Columbus.
THICK PLATE THEORIES, WITH APPLICATIONS TO VIBRATION Ph.D. Thesis
Nagy Fouad Hanna 1990 255 p
Avail: Univ. Microfilms Order No. DA9105122

A literature review was made to compare the various approaches dealing with the deformations of thick plates. One approach was chosen and applied by making use of two shear deformation theories, a first order and a higher order one. The two theories were used with the Ritz method to study the free vibration of the completely free thick plate. Numerical results are presented for the frequency parameters as well as mode shapes. The effects of different parameters (Poisson's ratio, aspect ratio, and thickness to width ratio) were studied. It was found that first order shear deformation theories overcorrect the classical theory natural frequencies and higher order theories recorrect them.
Dissert. Abstr.

N91-24631 Texas A&M Univ., College Station.
ACTIVE VIBRATION CONTROL OF ROTORBEARING SYSTEMS UTILIZING PIEZOELECTRIC PUSHERS Ph.D. Thesis
Reng Rong Lin 1990 247 p
Avail: Univ. Microfilms Order No. DA9106960

Theories were developed and tests were conducted for incorporating piezoelectric pushers as actuator devices for active vibration control. It started from a simple model with the assumption of ideal pusher characteristics and progressed to sophisticated electro-mechanical models with nonideal pushers. Effects on system stability due to the nonideal characteristics of piezoelectric pushers and other elements in the control loop were studied. Application of modal space optimal control with output feedback to the control of rotordynamic transient vibrations from blade loss was studied. The transient vibration level of rotordynamic systems was shown to be largely reduced by the optimal control method. Three active vibration control (AVC) theories (optimal control, pole placement, and uncoupled velocity feedback) were extended to treat the special prescribed internal displacement character of piezoelectric pushers. Theories of soft mounted piezoelectric pushers as actuators for AVC of rotor bearing systems, were developed to minimize the effects to the rotor from the excited casing modes. Dissert. Abstr.

N91-24632 California Inst. of Tech., Pasadena.
ANALYSIS AND IDENTIFICATION OF LINEAR AND NONLINEAR NORMAL MODES IN VIBRATING SYSTEMS Ph.D. Thesis
Alexander F. Vakakis 1991 336 p
Avail: Univ. Microfilms Order No. DA9107401

Certain nonlinear Hamiltonian systems possess what is termed normal modes. These are oscillations which pass through the origin of the configuration space and intersect the maximum equipotential surface orthogonally. Methods for computing normal modes and their bifurcations are presented. Local stability is determined by approximate Mathieu equations. For a two degree of freedom, nonlinear system, the global dynamics are studied by Poincare maps. For low energies, an averaging analysis is used to show that the flow on the Poincare map is equivalent to that on a two torus. Steady state motions of strongly nonlinear systems are examined by considering special forcing functions. Although the principle of linear superposition does not hold in this case, it is shown that forced resonant vibrations can still occur in the neighborhood of the normal modes. A challenging problem in linear theory is the development of modal analysis techniques for identifying normal modes in practical vibrating structures. Techniques for identifying systems with closely spaced modes and weak nonlinearities, are developed. Based on the results, refined identification algorithms are proposed, and are tested by analyzing two kinds of data. Dissert. Abstr.

N91-24633 California Inst. of Tech., Pasadena.
STRESSES NEAR A CHANGE OF THICKNESS IN A CONTINUOUS FIBER COMPOSITE PLATE Ph.D. Thesis
Thomas J. Kubr 1990 68 p
Avail: Univ. Microfilms Order No. DA9107388

The results are presented of a numerical study of the stresses near an abrupt change in thickness of a composite plate. The plate is a laminate of unidirectional, continuous fiber plies. The failure behavior of co-cured stringer reinforced composite plates and shells was studied. The analysis was performed in a plane normal to the stringer axis. The problem formulation is similar to plane strain. Because orthotropic materials are involved, a solution method allowing 3-D displacements as functions of two spatial variables was applied. The method is called plane coupled strain. Failure is assumed to initiate at the sharp 90 deg reentrant corner of the step-down geometry due to a rise in stresses. The resulting stress singularity is characterized for different combinations of stacking orders in the stepped plate. Stresses in the structure are determined by means of the finite element method. The results are presented in two parts: the differences obtained with plane coupled strain and classical plane strain is described along with the stress singularity. The results for the stress singularity are used in an example failure criterion. Stacking sequences are examined with respect to their susceptibility to failure.
Dissert. Abstr.

N91-24634 Florida Univ., Gainesville.
STRUCTURAL DAMAGE ASSESSMENT USING IDENTIFICATION TECHNIQUES Ph.D. Thesis
Francisco Jose daCun Soeiro 1990 195 p
Avail: Univ. Microfilms Order No. DA9106477

An approach is described for structural damage assessment that has its basis in methods of system identification. Response of a damaged structure differs from predictions obtained from an analytical model of the original structure, where the analytical model is typically a finite element representation. Output error and equation error methods of system identification are employed to determine changes in the analytical model necessary to minimize differences between the measured and predicted response. Structural damage is represented by changes in element stiffness matrices resulting from variations of geometry of material properties of the structure during damage. Measurements of static deflections and vibration modes are used in the identification procedure. A rational basis for the proper selection of eigenmodes and loading conditions for the identification process is developed. Representative structural systems made of isotropic as well as orthotropic materials are solved to validate the approach. An experimental setup consisting of a simple planar isotropic truss structure was constructed to demonstrate the applicability of the approach to actual structures. Dissert. Abstr.

N91-24635 Delaware Univ., Newark.
FREE VIBRATION ANALYSIS OF LAMINATED COMPOSITE SHELLS OF REVOLUTION INCLUDING TRANSVERSE SHEAR DEFORMATION Ph.D. Thesis
Altan Kayran 1990 257 p
Avail: Univ. Microfilms Order No. DA9101086

An analysis is presented for the study of the effect of transverse shear deformation on the natural frequencies of laminated composite shells of revolution. The applicability of linear shell theory due to Reissner is assumed. For the improved shell theory, in which transverse shear deformation is taken into account, the governing equations are reduced to ten first order homogeneous ordinary differential equations involving ten unknowns. Natural frequencies and mode shapes are solved for, by applying the combination of modal iteration and frequency trial methods to the first order system of differential equations of the classical and improved shell theories. Uncoupled torsional vibration qualities of layered composite shells of revolution is analyzed separately, and conditions for the uncoupling of the torsional modes from the bending-extensional model are determined. The extension of the application of frequency trial method to the solution of axisymmetrically prestressed composite shells of revolution is also carried out. The modified equations are verified for their correctness by solving the natural frequencies of spinning circular disks and comparing them with the exact solution. Dissert. Abstr.

N91-24636*# Finite Element Factory, Sunnyvale, CA.
THE MHOST FINITE ELEMENT PROGRAM: 3-D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS. VOLUME 1: THEORETICAL MANUAL Final Report
Shohei Nakazawa May 1991 77 p
(Contract NAS3-23697)
(NASA-CR-182205; NAS 1.26:182205) Avail: NTIS HC/MF A05 CSCL 20K

Formulations and algorithms implemented in the MHOST finite element program are discussed. The code uses a novel concept of the mixed iterative solution technique for the efficient 3-D computations of turbine engine hot section components. The general framework of variational formulation and solution algorithms are discussed which were derived from the mixed three field Hu-Washizu principle. This formulation enables the use of nodal interpolation for coordinates, displacements, strains, and stresses. Algorithmic description of the mixed iterative method includes variations for the quasi static, transient dynamic and buckling analyses. The global-local analysis procedure referred to as the subelement refinement is developed in the framework of the mixed iterative solution, of which the detail is presented. The numerically integrated isoparametric elements implemented in the framework is discussed. Methods to filter certain parts of strain and project the element discontinuous quantities to the nodes are developed for a family of linear elements. Integration algorithms are described for linear and nonlinear equations included in MHOST program.
Author

N91-24637# Sydney Univ. (Australia). School of Civil and Mining Engineering.
OUT-OF-PLANE STRENGTHS OF STEEL BEAMS
S. Bild, G. Chen, and N. S. Trahair Jan. 1988 73 p
(PB91-137471; R-560) Avail: NTIS HC/MF A04 CSCL 20K

A general finite element method of analyzing the nonlinear effects of instability and yielding on the bi-axial bending and torsion of steel I-section members with residual stresses and geometrical imperfections is presented. The analysis assumes tangent modulus behavior of the elastic-plastic-strain hardening material, and makes simple approximations for the effects of shear on yielding and for the shear modulus of the yielded and strain-hardened material. The results obtained from a computer program based on the element are compared with a range of available solutions to confirm the accuracy of the method in predicting the effects of geometrical imperfections, instability, biaxial bending and torsion, residual stresses, and yielding and strain hardening. Dissert. Abstr.

N91-24638# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
ANALYTICAL QUALIFICATION OF AIRCRAFT STRUCTURES
Apr. 1991 171 p In ENGLISH and FRENCH The 70th Meeting was held in Sorrento, Italy, 1-6 Apr. 1990
(AGARD-R-772; ISBN-92-835-0603-0) Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The role of structural analysis in relation to aircraft qualification procedures was addressed in order to establish guidelines for the future and to seek out those areas where there exists a commonality of approach between nations. Topics covered include: quality assurance of software tools for structural analysis; comparison of analysis and test results; and trends in analysis for certification/certification only by analysis. For individual titles, see N91-24639 through N91-24652.

N91-24639# Rolls-Royce Ltd., Derby (England).
A ROLE MODEL FOR QUALITY MANAGEMENT IN FINITE ELEMENT ANALYSIS **c61**
John Barlow *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 12 p (For primary document see

N91-24638 16-39)
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Many engineering companies use a quality management system to ISO 9001 as a means of controlling quality and standards in their products and operations. The National Agency for Finite Element Methods and Standards has recently issued a quality systems supplement on the application of ISO 9001 to the use of finite element analysis in the design and validation of engineering products. A role model is presented for a quality system designed to fulfill the requirements of that document. Quality aspects of the following topics are covered: management of the analysis operation; acquisition; development and verification of software; qualification and documentation of analysis methods; project analysis; and education and training of personnel. Comments are included, based on experience of implementing finite element quality procedures.
Author

N91-24640# Aerospatiale, Toulouse (France). Structural Research and Development Dept.
VALIDATION OF IN-HOUSE AND EXTERNAL SOFTWARE SYSTEMS AT AEROSPATIALE **c61**
J. Locatelli and J. C. Sourisseau *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 3 p (For primary document see N91-24638 16-39)
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In the aeronautical industry, the concept of numerical simulation is implemented, at first, in the preliminary design stage, and then during the certification activities with respect to the airworthiness regulations. This implies the development and the use of calculation software, of which it is necessary to improve the validation at different levels. The different features of these validation tests are described in the design, use, and evaluation of these software systems. The experience of the engineer then plays a major role in obtaining high quality models in the design of aircraft structures.
Author

N91-24641# Wright Research Development Center, Wright-Patterson AFB, OH.
ANALYTICAL CERTIFICATION OF AIRCRAFT STRUCTURES
V. B. Venkayya *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 14 p (For primary document see N91-24638 16-39)
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Analysis is expected to play an important role in the design and validation of future aircraft structures. The need for the development of professional standards in order to implement the concept of analytical certification is presented. Standards for analysis and criteria for model definition are discussed in some detail.
Author

N91-24642# Construcciones Aeronauticas S.A., Madrid (Spain). Stress Office.
NONLINEAR ANALYSIS OF COMPOSITE SHEAR WEBS WITH HOLES AND CORRELATION WITH TESTS
J. M. Blanco Saiz and A. Barrio Cardaba *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 17 p (For primary document see N91-24638 16-39)
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Since the use of composite materials is largely extended in aircraft construction, it is necessary to develop analytical calculations to avoid the present dependency on structural tests. With that objective, a test plan of 25 representative specimens of 9 different shear webs geometries with accessing, inspecting or lightening holes, enveloping the A320 tailplane design was performed, including simulated defects and impacts for two environmental conditions. Finite element linear and nonlinear analysis, using a very refined mesh, was performed to correlate test results. Very good correlation was found even in the postbuckling behavior of the structure. This analysis allows the prediction of the postbuckling capability of these structural elements and the derivation of a failure criteria.
Author

N91-24643# Beech Aircraft Corp., Wichita, KS.
BEECHCRAFT STARSHIP STRENGTH CERTIFICATION
E. H. Hooper *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 7 p (For primary document see N91-24638 16-39)
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The all-composite airframe can be successfully designed and analyzed with today's technology. Simple designs using essentially monocoque techniques facilitate economical fabrication of parts and assemblies. An FAA certification program demands careful planning and coordination, especially concerning regulations, interpretations, test criteria, test plans, and test witnessing.
Author

N91-24644# Air Force Materials Lab., Wright-Patterson AFB, OH.
THE ROLE OF ANALYSIS IN THE DESIGN OF COMPOSITE MATERIALS
Stephen W. Tsai, Jocelyn M. Patterson, Jose L. Perez, and Steven L. Donaldson *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 6 p (For primary document see N91-24638 16-39)
Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The current role of analysis in the design of advanced polymer composite materials is presented. The correlation between structural property prediction and measurement is discussed for both material characterization and component testing. It is reported that to predict the stiffness of multidirectional laminates from the unidirectional material properties, laminated plate theory is reasonably accurate and generally accepted. Strength predictions are much more difficult because of the large variety of failure mechanisms, and some of the existing failure criteria are inaccurate. Because of its simplicity, the most widely used is the maximum strain criterion, although it ignores multiple failure mode interactions and is not easily adaptable to model progressive failures. A much better alternative is the quadratic failure criterion, acknowledged as the most sound analytically, internally consistent and easily adaptable to progressive failures, but still not generally accepted by most of industry. Following an assessment of the most advanced and most accurate analytical techniques is a discussion of a few of the most detrimental, although commonly accepted, shortcuts to analysis. It is concluded that: (1) the role of analysis is critical, (2) the best contemporary analysis techniques are under utilized, and (3) widely used current practices are compromised by use of outdated rules. It is recommended that analytical tools be built on fundamentals, developing an integrated micro-macro-mechanics design methodology, with the goal of using analysis rationally to tailor new materials. The full potential of composite materials can then be realized.
Author

N91-24645# Fokker B.V., Schipol-Oost (Netherlands).
EVALUATION OF THE QUALIFICATION OF THE STRUCTURE OF A PASSENGER AIRCRAFT BY ANALYSIS AND FULL-SCALE TESTING
H. A. vanDullemen *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 12 p (For primary document see N91-24638 16-39)
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On the basis of the experience with the Fokker 100 development and full-scale testing, the qualification process leading to a certified aircraft structure is reviewed. The question whether the state of the art is satisfactory or not is discussed, seen from the viewpoint of the FEM (finite element method) specialist, the manager, the structural specialist, and the authorities. Special attention is given to the problems with derivative aircraft with respect to the requirements. Computer simulation as a replacement for full-scale

testing is discussed and rejected. The practical compromises in full-scale testing and FEM model verification are discussed and some crucial experiences with the test program are considered.
Author

N91-24646# Imperial Coll. of Science and Technology, London (England).
DESIGN-ANALYSIS-TEST
G. A. O. Davies *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 14 p Sponsored in part by Ministry of Defence, England and Science Research Council, England (For primary document see N91-24638 16-39)
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The role of structural analysis in the design-analysis-test cycle is addressed, and particularly the role of finite element analysis. It is suggested that the dominance of finite element code application in structural analysis is moving from simple stress and deformation evaluation to the prediction of failure, particularly in areas where multiple testing would otherwise be necessary. The use of analysis to predict failure, instead of experimental tests, raises many problems, and these will be exacerbated if finite element codes become common tools of non-specialists. A way forward is suggested.
Author

N91-24647# Royal Aerospace Establishment, Farnborough (England). Materials and Structures Dept.
THE ROLE OF STRUCTURAL ANALYSIS IN AIRWORTHINESS CERTIFICATION
P. Bartholomew *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 8 p (For primary document see N91-24638 16-39)
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Those uses of structural analysis which have a bearing on airworthiness are reviewed. In particular, the extent to which finite element analysis is already implicitly relied on in the context of clearance by test is considered, and factors which may be expected to lead to an increased reliance are discussed. One such factor is the increased use of the computer aided engineering (CAE) approach which changes the design process itself. An assessment is made of actions required to ensure that results of analysis provide a consistent and reliable basis for airworthiness judgement.
Author

N91-24648# Canadair Ltd., Montreal (Quebec).
THE ROLE OF ANALYSIS IN THE DESIGN AND QUALIFICATION OF COMPOSITE AIRCRAFT STRUCTURES
Patrick McConnell *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 12 p (For primary document see N91-24638 16-39)
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Four areas of analysis in the qualification of aircraft structures made with composite materials are discussed. These areas are (1) statistics for material allowables, (2) damage tolerance modelling, (3) hygrothermal modelling, and (4) buckling of stiffened compression panels.
Author

N91-24649# Dassault-Breguet Aviation, Saint Cloud (France).
INFLUENCE OF THE REFINEMENT OF STRUCTURAL CALCULATION ON AIRCRAFT QUALIFICATION PROCEDURES
C. Petiau *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 14 p In FRENCH; ENGLISH summary (For primary document see N91-24638 16-39)
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The effects of improvements of analytical methods on the process of airframe qualification are examined. Potentialities, weaknesses, and corresponding corrections are reviewed for the three main branches of structural analysis of aircraft: calculation of stress fields, determination of failure criteria in static and in fatigue, and calculation of loads, aeroelasticity, and flutter. Risks of errors are omnipresent, so the structure qualification must include a reliable process of detection and correction of errors. An organization plan for design and qualification is presented. Computer analysis plays a large role, while remaining controlled via a minimum number of relevant tests. Improvements in analytical methods assist design optimization by reducing the number of required tests and reducing the risk of failure during the main qualification tests. However, insufficient reliability of analytical methods, mainly the risk of human error, requires continued use of the main qualification tests.
Author

N91-24650# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
ANALYTICAL METHODS FOR THE QUALIFICATION OF HELICOPTER STRUCTURES
F. Och *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 14 p (For primary document see N91-24638 16-39)
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Due to the increasing costs of experimental testing, analytical methods are becoming the primary means of demonstrating structural integrity, durability, and crashworthiness of helicopter structures, both for civil and military use, when representative conditions such as temperature, moisture, cyclic loading, and impact have to be considered. The airframes of derivatives of the basic BO 105 have been qualified in the past without retesting because it could be shown that the structure conformed to those for which experience had demonstrated the structural analysis to be reliable. During the development of a composite fuselage for the BK 117, both an analytical and an experimental strength substantiation was performed, which corresponded very well and formed the basis for airworthiness qualification of this experimental helicopter under flight testing now. A large number of components in the dynamic system are designed primarily so that they will provide adequate fatigue strength, defined in terms of an endurance limit, or in terms of fatigue life. The analytical qualification of these fatigue critical structures, on the basis of measured fatigue loadings and calculated working S-N curves, is state-of-the-art in the helicopter industry. In the nonlinear domain, analytical methods are applied for highly laminated elastomeric bearings and for the crashworthiness qualification of both crushable subcomponents and complete helicopters. The results gained so far allow the application of analytical methods, partly in combination with coupon or component testing, for the qualification of helicopter structures.
Author

N91-24651# Fokker B.V., Schipol-Oost (Netherlands).
SOLAR ARRAY QUALIFICATION THROUGH QUALIFIED ANALYSIS **c44**
J. Zijdemans, H. J. Cruijssen, and J. J. Wijker *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 11 p (For primary document see N91-24638 16-39)
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To achieve qualification is in general a very expensive exercise. For solar arrays this is done by a dedicated test program through which final qualification is achieved. Due to severe competition on the solar array market, cheaper means are looked for to achieve a qualified product for the customers. One of the methods is to drastically limit the environmental test program and to qualify the solar-array structure against its environmental loads by analysis. Qualification by analysis is possible. The benefits are that a significant amount of development effort can be saved in case such a powerful tool is available. Extensive testing can be avoided thus saving time and money.
Author

N91-24652*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROBABILITY APPROACH FOR STRENGTH CALCULATIONS
Christos C. Chamis and T. A. Cruse (Southwest Research Inst., San Antonio, TX.) *In* AGARD, Analytical Qualification of Aircraft

Structures Apr. 1991 13 p (For primary document see N91-24638 16-39)
Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 20K

The use of probabilistic structural analysis methods (PSAM) to predict structural reliability is the subject of an on-going NASA research program. The elements of the new technology developed to date is reported. Applications of the developed software to structural problems are demonstrated for simple validation problems and for large scale application problems. On-going research to support component and system reliability predictions suitable for analytical certification of aerospace structures is briefly reviewed.
Author

N91-24653# Stanford Univ., CA. Dept. of Materials Science and Engineering.
FUNDAMENTAL STUDIES OF THE MECHANICAL BEHAVIOR OF MICROELECTRONIC THIN FILM MATERIALS Annual Report, 15 Nov. 1989 - 14 Nov. 1990
William D. Nix Jan. 1991 75 p
(Grant AF-AFOSR-0185-89; AF Proj. 2305)
(AD-A232935; AFOSR-91-0114TR) Avail: NTIS HC/MF A04 CSCL 20/11

Research progress on the study of stresses and mechanical behavior of microelectronic thin films is reported. Specialized instruments have been developed to study stress relaxation in metal and semiconductor thin films, diffusion of water in passivation films and crystallization of amorphous silicon films. Finite element techniques have been used to determine stresses in passivated interconnect metal lines. These stresses have been used in a model of interconnect metal cracking that has been developed. It has been shown that the high concentrations of oxygen present in LRP (limited reaction processed) Si-Ge films greatly inhibits misfit dislocation formation. GRA

N91-24654# Department of the Navy, Washington, DC.
IN-LINE LOAD CELL FOR FLEXIBLE STRENGTH MEMBER MATERIALS Patent Application
Joseph Liguorer, inventor (to Navy) 27 Aug. 1990 13 p
(AD-D014815; US-Patent-Appl-SN-573971) Avail: NTIS HC/MF A03 CSCL 13/8

The present invention generally relates to load cells and more particularly to an in-line load cell for measuring in-line tension for flexible strength member materials. As materials technology has improved over the years, flexible strength members such as Kevlar and Dacron have replaced rigid strength members such as standard steel cables. It is naturally desirable to accurately measure in-line tension in the flexible strength members. In-line tension is defined as tension in the same line of action as the strength member away. It is an object of the present invention to provide an in-line load cell for flexible strength member materials that measure tension in the strength member's line of action. It is a further object of the present invention to provide an in-line load cell for flexible strength member materials that does not require termination of the strength member. GRA

N91-24655# Virginia Polytechnic Inst. and State Univ., Blacksburg. Interdisciplinary Center for Applied Mathematics.
ENERGY DECAY AND BOUNDARY CONTROL FOR DISTRIBUTED PARAMETER SYSTEMS WITH VISCOELASTIC DAMPING Final Technical Report, 15 May 1989 - 14 Nov. 1990
Kenneth B. Hannsgen and Robert L. Wheeler 3 Jan. 1991 11 p
(Grant AF-AFOSR-0268-89; AF Proj. 2304)
(AD-A232997; AFOSR-91-0180TR) Avail: NTIS HC/MF A03 CSCL 20/11

This report concerns several aspects of damping and control in distributed parameter systems, with emphasis on applications to elastic and viscoelastic structures. For viscoelastic bodies, the ineffectiveness of boundary feedback for damping nonoscillatory creep decay was demonstrated, and a precise energy space formulation was developed for the viscoelastic wave equation. In addition, a reachability result was proved for a second-order linear integral equation. For elastic beams and plates, exact controllability and the exponential decay of energy were established in new settings. These include uniform exponential decay of energy by means of locally distributed damping in a one-dimensional nonhomogeneous medium, and, under certain boundary conditions, for longitudinal vibrations in a thermoelastic rod. GRA

N91-24656# Pennsylvania State Univ., University Park. Materials Research Lab.
PASSIVE VIBRATION DAMPING Final Technical Report, 1 Jan. - 31 Dec. 1990
S. K. Kurtz and Shoko Yoshikawa Jan. 1991 48 p
(Contract N00014-90-J-1540)
(AD-A233197) Avail: NTIS HC/MF A03 CSCL 20/11

Several attempts have been made to make vibration dampers using piezoelectric damping effect. Among PZT ceramic samples made in the course of this research, PZT stack sample with optimally tuned external resistor gave a maximum mechanical loss of 0.25 and elastic modulus of 70 to 90 GPa measured using an electrical resonance technique. In order to utilize piezoelectric damping effect for structural materials, PZT with polymer or metal matrix have also been studied. Using PZT or PbTiO3 powders as a filter, a large number of ceramic-polymer 0 to 3 connectivity composites have been manufactured and evaluated, though extremely low coupling coefficient (k2) of these composites made them poor piezoelectric dampers. A PZT toroid embedded in solder metal matrix shunted by external optimal resistor gave tan sigma of 0.16 comparing with 0.03 of no external register attached. Though this proved the concept of PZT-metal composites as effective passive damper, processing difficulties associated with metal matrix piezoelectric composites need to be overcome in the future. GRA

N91-24657# Naval Research Lab., Washington, DC.
THREE DIMENSIONAL VARIABLE CONSTRAINT EFFECTS IN FRACTURE INITIATION Memorandum Report
V. G. DeGiorgi 25 Mar. 1991 55 p
(NR Proj. RR0-2201)
(AD-A233386; NRL-MR-6767) Avail: NTIS HC/MF A04 CSCL 11/6

Many naturally occurring cracks are three dimensional and cannot be evaluated using numerical techniques derived using two dimensional simplifications. The high stress and strain levels experienced in modern high toughness alloys prior to fracture require means to accurately simulate the nonlinear response of ductile materials in this regime. An accurate constitutive representation must be combined with a fracture criterion which is valid for the high strain regime to achieve accurate computerized simulations of fracture and near fracture behavior. In the current work, nonlinear numerical simulations are performed to determine the global and local responses of two surface cracked plates of HY-100 steel with varying crack propagation and crack depths. Failure is defined by a local fracture criterion using strain energy density. Differences in constraint along the crack perimeter are taken into account by recognizing the stress-strain history dependence of the critical strain energy density. Crack growth patterns determined from the numerical simulations accurately reflect experimental observations. GRA

N91-24658# Southwest Research Inst., San Antonio, TX.
CRACK GROWTH PROCESSES AT ELEVATED TEMPERATURES IN ADVANCED MATERIALS Annual Report, 1990
David L. Davidson, Kwai S. Chan, and James Lankford Jan. 1991 75 p
(Contract F49620-89-C-0032)
(AD-A233574; SwRI-06-2699/2) Avail: NTIS HC/MF A04 CSCL 20/11

Crack tip micromechanics measurements made on the mechanisms of fatigue crack growth were investigated by direct observation of crack growth using a cyclic stage in the scanning electron microscope. Direct measurements of fatigue crack closure

were made for center notched specimens of the aluminum alloy 7091, and these were compared to similar measurements from single edge notched specimens of the same alloy. The results indicate that plasticity induced closure can be treated in a systematic way and is linked to the threshold for fatigue crack growth. A simple model was developed which can be used to simulate the opening of fatigue cracks. These results were then compared to similar information from stainless steel, aluminum, and titanium alloys. Some general conclusions about closure were identified. The roles of microstructure in the fracture toughness and tensile ductility of the two-phase Ti3Al-base and TiAl base alloys were established by identifying the relevent fracture and toughness processes in these alloys by performing crack-tip micromechanics experiments both at ambient and elevated temperatures. GRA

N91-24659*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LOCALIZATION OF AEROELASTIC MODES IN MISTUNED HIGH-ENERGY TURBINES
Christophe Pierre, Todd E. Smith, and Durbha V. Murthy (Toledo Univ., OH.) 1991 37 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(Contract NAS3-25266; NAG3-1163; NAG3-742; NASA Order C-99066-G)
(NASA-TM-104445; ICOMP-91-11; E-6285; NAS 1.15:104445; AIAA-91-3379) Avail: NTIS HC/MF A03 CSCL 20K

The effects of blade misturing on the aeroelastic vibration characteristics of high energy turbines are investigated, using the first stage of the oxidizer turbopump in the Space Shuttle Main Engine as an example. A model aeroelastic analysis procedure is used in concert with a linearized unsteady aerodynamic theory that accounts for the effects of blade thickness, camber, and steady loading. Extreme sensitivity of the dynamic characteristics of mistuned rotors is demonstrated. In particular, the aeroelastic modes become localized to a few blades, possibly leading to rogue blade failure, and the locus of the aeroelastic eigenvalues loses its structure when small mistunings (of the order present in actual rotors) are introduced. Perturbation analyses that yield physical insights into these phenomena are presented. A powerful but easily calculated stochastic sensitivity measure that allows the global prediction of mistuning effects is developed. Author

N91-24660*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MODELING OF CRACK BRIDGING IN A UNIDIRECTIONAL METAL MATRIX COMPOSITE
Louis J. Ghosn (Sverdrup Technology, Inc., Brook Park, OH.), Pete Kantzos, and Jack Telesman May 1991 22 p
(NASA-TM-104355; E-6142; NAS 1.15:104355) Avail: NTIS HC/MF A03 CSCL 20K

The effective fatigue crack driving force and crack opening profiles were determined analytically for fatigue tested unidirectional composite specimens exhibiting fiber bridging. The crack closure pressure due to bridging was modeled using two approaches; the fiber pressure model and the shear lag model. For both closure models, the Bueckner weight function method and the finite element method were used to calculate crack opening displacements and the crack driving force. The predicted near crack tip opening profile agreed well with the experimentally measured profiles for single edge notch SCS-6/Ti-15-3 metal matrix composite specimens. The numerically determined effective crack driving force, Delta K(sup eff), was calculated using both models to correlate the measure crack growth rate in the composite. The calculated Delta K(sup eff) from both models accounted for the crack bridging by showing a good agreement between the measured fatigue crack growth rates of the bridged composite and that of unreinforced, unbridged titanium matrix alloy specimens. Author

N91-24239# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
STRUCTURAL DAMPING/ACOUSTIC ATTENUATION OPTIMIZATION VIA NON-OBSTRUCTIVE PARTICLE DAMPING
H. V. Panossian *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 2 Oct. 1990 p 63-71 (For primary document see N91-24233 16-20)
Avail: NTIS HC/MF A20

N91-24308*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF THE FATIGUE/FRACTURE/LIFE WORKING GROUP PROGRAM AT THE LEWIS RESEARCH CENTER
Michael A. McGaw *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 1-3 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24309*# Pratt and Whitney Aircraft, East Hartford, CT.
APPLICATION OF CYCLIC DAMAGE ACCUMULATION LIFE PREDICTION MODEL TO HIGH TEMPERATURE COMPONENTS
Richard S. Nelson *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 5-15 (For primary document see N91-24307 16-20)
(Contract NAS3-23288)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24310*# United Technologies Research Center, East Hartford, CT.
NOTCHED FATIGUE OF SINGLE CRYSTAL PWA 1480 AT TURBINE ATTACHMENT TEMPERATURES
T. G. Meyer, D. M. Nissley, and G. A. Swanson (Pratt and Whitney Aircraft, East Hartford, CT.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 17-23 (For primary document see N91-24307 16-20)
(Contract NAS3-23939)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24314*# General Electric Co., Cincinnati, OH. Life Assessment and Methods Technology.
ELEVATED TEMPERATURE CRACK GROWTH
K. S. Kim and R. H. VanStone *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 45-52 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24315*# Toledo Univ., OH.
ANALYSIS OF DAMAGE IN MMC COMPONENTS USING AN INTERNAL STATE VARIABLE MODEL
V. K. Arya *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 53-57 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24319*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TWO-DIMENSIONAL HIGH TEMPERATURE STRAIN MEASUREMENT SYSTEM
Christian T. Lant (Sverdrup Technology, Inc., Cleveland, OH.) and John P. Barranger *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 83-86 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24326*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROBABILISTIC STRUCTURAL ANALYSIS: INTRODUCTORY REMARKS Abstract Only
Christos C. Chamis *In its* Structural Integrity and Durability of

Reusable Space Propulsion Systems Apr. 1989 p 137-138 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24327*# Southwest Research Inst., San Antonio, TX.
PROBABILISTIC STRUCTURAL ANALYSIS METHODS FOR SELECT SPACE PROPULSION SYSTEM COMPONENTS
H. R. Millwater and T. A. Cruse *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 139-144 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24328*# Southwest Research Inst., San Antonio, TX.
AN APPROXIMATE METHODS APPROACH TO PROBABILISTIC STRUCTURAL ANALYSIS
R. C. McClung, H. R. Millwater, Y.-T. Wu, B. H. Thacker, and O. H. Burnside *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 145-151 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24329*# Southwest Research Inst., San Antonio, TX.
PROBABILISTIC BOUNDARY ELEMENT METHOD
T. A. Cruse and S. T. Raveendra *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 153-158 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24330*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
COMPOSITE LOAD SPECTRA FOR SELECT SPACE PROPULSION STRUCTURAL COMPONENTS
H. Ho, J. F. Newell, and R. E. Kurth (Battelle Columbus Labs., OH.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 159-166 (For primary document see N91-24307 16-20)
(Contract NAS3-24382)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24331*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
PROBABILISTIC DESIGN ANALYSIS USING COMPOSITE LOADS SPECTRA (CLS) COUPLED WITH PROBABILISTIC STRUCTURAL ANALYSIS METHODOLOGIES (PSAM)
J. F. Newell, K. R. Rajagopal, and H. Ho *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 167-180 (For primary document see N91-24307 16-20)
(Contract NAS3-24382)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24332*# Northwestern Univ., Evanston, IL. Dept. of Mechanical Engineering.
PROBABILISTIC FINITE ELEMENTS FOR FRACTURE AND FATIGUE ANALYSIS
W. K. Liu, T. Belytschko, M. Lawrence, and G. H. Besterfield *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 181-195 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24333*# Sverdrup Technology, Inc., Cleveland, OH.
PROBABILITY OF FAILURE AND RISK ASSESSMENT OF PROPULSION STRUCTURAL COMPONENTS
Michael C. Shiao *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 197-208 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

N91-24334*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF AEROTHERMODYNAMIC LOADS DEFINITION STUDY
Raymond E. Gaugler *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems Apr. 1989 p 209-214 (For primary document see N91-24307 16-20)
Avail: NTIS HC/MF A12 CSCL 20K

42 GEOSCIENCES (GENERAL)

N91-24661# Meteorological Satellite Center, Tokyo (Japan).
METEOROLOGICAL SATELLITE CENTER TECHNICAL NOTE, NO. 21, 1990
Dec. 1990 87 p In ENGLISH and JAPANESE
(ISSN-0388-9653; MSC-TN-21) Avail: NTIS HC/MF A05

This Japanese journal mainly reports on the data acquisition and operation of the Geostationary Meteorological Satellite (GMS). Some of the topics included are as follows: Characteristics of GMS-4 VISSR; Influence of the polar atmosphere on the image mapping using Earth edge data; Use of wind data derived from GMS in the upper tropics; Added information by man machine interactive operation of the SCIC; An estimation of surface wind profiles within the range of 200 km from a typhoon center using GMS images; and Scintillation observed on the GMS communication link. For individual titles, see N91-24662 through N91-24668.

N91-24662# Meteorological Satellite Center, Tokyo (Japan).
CHARACTERISTICS OF GMS-4 VISSR **c43**
Yoshishige Shirakawa and Masayuki Sasaki *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 1-10 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

The characteristics of GMS-4 VISSR were examined using the image data of mission check and routine operation. The characteristics of GMS-4 VISSR are as follows: The temporal and spatial resolution of the infrared channel was improved after infrared focus adjustment; The temporal range of the infrared primary channel was wider than the redundant one, and the visible sensor sensitivity of primary channels was more uneven than the redundant one. X-component of VISSR misalignment was about -0.07 deg and Y-component was 0.04 deg. Tilt direction was about -58.0 deg and tilt angle was about 0.08 deg. The location difference of corresponding infrared and visible pixel of primary channel was 6.32 visible pixels in the direction of scanning and -0.02 lines of visible pixel in the direction of mirror stepping. The lag of pixels was corrected by VISSR equipment in CDAS (Command and Data Acquisition Station). The nutation of spin axis which caused the line of sight disturbance was not found on single scan and multi-segment observation. GMS-4 has operated routinely from 4th Dec. 1989. Author

N91-24663# Meteorological Satellite Center, Tokyo (Japan).
INFLUENCE OF THE POLAR ATMOSPHERE ON THE IMAGE MAPPING USING EARTH EDGE DATE **c43**
Seiichiro Kigawa *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 11-17 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

Image mapping is of great importance to Geostationary Meteorological Satellite (GMS) Visible Infrared Spin Scan Radiometer (VISSR) data user. VISSR image mapping uses Earth edge information for the improvement of accuracy. An accuracy of the image mapping estimated from landmark matching data shows a seasonal variation. Cause for the seasonal variation of the accuracy is ascribed to the algorithm of the present image

mapping which does not take into account the seasonal variation of the atmospheric thickness in the polar regions. Author

N91-24664# Meteorological Satellite Center, Tokyo (Japan).
A USAGE OF WIND DATA DERIVED FROM GMS IN THE UPPER TROPICS **c47**
Kazumasa Tada *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 25-32 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

A use of wind data derived from satellite pictures is proposed to improve the objective analysis of the wind in the upper tropical troposphere. The vertical wind profile observed by RAWIN sonde is expanded by the 16 eigenfunctions which had been used in the JMA initialization scheme of the global spectral model. The first and second vertical modes are removed from the observed wind profile and the new wind profile is composed by the remaining 14 eigenfunctions. The resultant wind data are compared with the satellite wind data located within 150 km of the station. The Root Mean Square between the new wind data and satellite wind data is less than that done in the conventional way. The accuracy of the proposed way does not depend on the level assignment of satellite wind, i.e., at 200 or 250 mb. It follows that a proposed way to use the satellite wind data leads to better assessment. The proposed way includes a possible technique which will take advantage of the numerical prediction not only in quality control, but also in the process of derivation for higher assessment of satellite wind. Author

N91-24665# Meteorological Satellite Center, Tokyo (Japan).
ADDED INFORMATION BY MAN-MACHINE INTERACTIVE OPERATION OF THE SCIC **c54**
Yoshihiko Ando *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 33-46 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

Answers were received from questionnaires on the Satellite Cloud Information Chart (SCIC) from users, and then improved to be more useful. The summary of the answers is presented, and improvements and some uses of the SCIC are explained. Author

N91-24666# Meteorological Satellite Center, Tokyo (Japan).
AN ESTIMATION OF SURFACE WIND PROFILE WITHIN THE RANGE OF 200 km FROM A TYPHOON CENTER USING GMS IMAGES **c47**
Koetsu Chubachi *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 47-55 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

A technique is presented to estimate surface wind profile to the point 200 km from a typhoon center. This technique uses typhoon cloud parameters extracted from Geostationary Meteorological Satellite (GMS) images such as eye size, CDO size, cloud system size etc.. A radius at which the maximum wind speed is measured (hereafter called Rm) is estimated by regression analysis between Rm (700mb) measured by aircraft and cloud parameters. In order to derive regression equations, the typhoons were classified by the cloud pattern into three categories, i.e., EYE-pattern, CDO-pattern and OTHERS. In case of EYE-pattern and OTHERS, much less relationships are obtained. These results are acceptable because high correlation, as well known, exist between Rm and eye size. Results show that this technique makes a good estimation when a typhoon has an eye. Author

N91-24667# Meteorological Satellite Center, Tokyo (Japan).
THE REPRESENTATION OF Cb CLUSTER'S LIFE CYCLE USING TBB DATA AND RADAR DATA **c47**
Masami Sakurada *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 57-72 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

An attempt is made to describe the life stage of a cumulonimbus cloud (Cb) cluster by using some indices derived from GMS (Geostationary Meteorological Satellite) Black Body Temperature (T sub BB) data. To extract objectively Cb cluster areas, the following five criteria were used: (1) temperature of the area is composed of -30 C or colder; (2) at the boundary of the cloud area, delta T is greater than 1 C/km; (3) the area is greater than 1250 sq km; (4) cluster tracking is possible on hourly images; and (5) cluster does not separate or merge. T sub BB indices are examined and compared with coincident radar data within extracted area through life cycle. Result shows that the areal increment/decrement of T sub BB less than or = -50 C is the best index of developing/weakening of a Cb cluster. The difference between the highest and the lowest temperature is also a good index of Cb cluster's life stage. Relationships between maximum areal size and life time, and between the size and coldest temperature reached during life cycle are also investigated. Author

N91-24668# Meteorological Satellite Center, Tokyo (Japan).
SCINTILLATION OBSERVED ON THE GMS COMMUNICATION LINK **c32**
Hiroshi Tomita *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 73-85 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

The Geostationary Meteorological Satellite (GMS) communication link was affected by ionospheric scintillations which have often caused the degradation of the characteristics of the received signals. The observed scintillations on the GMS communication link and the aspects of the ionospheric scintillations are reviewed. Author

N91-24669*# National Aeronautics and Space Administration, Washington, DC.
THE HIGHLIGHTS OF 1989
1989 77 p
(NASA-TM-104985; NAS 1.15:104985) Avail: NTIS HC/MF A05 CSCL 13B

Activity of the Earth Science and Application Division in 1989 is reported. On overview of the work of Division is presented, and the main changes in previously announced flight schedules are noted. The following subject areas are covered: the Earth Observing System; studies of the stratospheric ozone; U.S.-U.S.S.R. collaboration in Earth sciences; cloud climatology and the radiation budget; studies of ocean color; global tropospheric chemistry studies; first ISLSCP (International Satellite Cloud Climatology Project) field experiment; and solid Earth science research plan. Author

43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

N91-24670 Tel-Aviv Univ. (Israel). Dept. of Interdisciplinary Study.
INVERSE FILTERING RESTORATION OF LANDSAT IMAGES BLURRED AS A RESULT OF THE ADJACENCY EFFECT M.S. Thesis
Shaul B. Ravid Jan. 1988 154 p
(ITN-90-85023) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 66978, Israel, pricing information obtainable from document source

Bathymetric measurements, obtained for LANDSAT images of

the Tiran area, suffer from inaccuracies due to the so-called adjacency effect. This effect occurs at regions containing a transition from an area with high reflectivity to an adjacent area with low reflectivity. The scattering in the atmosphere induces cross radiance between the two areas, causing the dark area to appear lighter and the light area darker. The effect decays with increasing distance from the border between the two areas. Thus, images originating from satellites with higher resolutions are going to suffer from this effect even more, as the absolute distance translates to more pixels. It is demonstrated, both theoretically and practically, that the inverse filter appropriately restores the images blurred by the adjacency effect. The filter is built-in software, with double precision and a special mechanism controlling the division by the MTF elements. The filter is show to be stable. It restores almost perfectly the Tiran images and does not increase the noise level. By restoring sample synthetic images, it is shown that the filter performs well when the noise is of the order of the quantization noise, and the images do not contain too high frequencies. The PSF is derived interactively from the image. It is argued that a more accurate derivation (e.g., from exact knowledge of the atmospheric parameters) would, most likely, improve the restoration accuracy. ISA

N91-24671*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
EARTH VIEW: A BUSINESS GUIDE TO ORBITAL REMOTE SENSING
Peter C. Bishop Jul. 1990 131 p
(Contract NCC9-16)
(NASA-CR-188238; NAS 1.26:188238) Avail: NTIS HC/MF A07 CSCL 08B

The following subject areas are covered: Earth view - a guide to orbital remote sensing; current orbital remote sensing systems (LANDSAT, SPOT image, MOS-1, Soviet remote sensing systems); remote sensing satellite; and remote sensing organizations. Author

N91-24672# Army Cold Regions Research and Engineering Lab., Hanover, NH.
PROCEEDINGS OF THE 47TH ANNUAL MEETING OF THE EASTERN SNOW CONFERENCE Special Report
Jun. 1990 306 p
(AD-A233320; CRREL-SR-90-44) Avail: NTIS HC/MF A14 CSCL 08/12

Topics discussed at the conference include: Air temperature variation over snow-covered terrain; Numerical investigation of border ice failure; Microscopic observations of snow deformation; What makes a good snow fence; Results from 12 years of testing; Ice detector measurements of atmospheric icing on a cable; Snowmelt runoff modeling using parameter estimation in a Western Adirondack watershed; Monitoring the snow water equivalent using synthetic aperture radar; Operational airborne and satellite snow cover products of the National Operational Hydrologic Remote Sensing Center; Developments in snow-chemistry research in the Western United States; Prototype physically-based model for prediction of the spatial distribution of snowcover; Objective guidance for 1- and 2-Day mesoscale forecasts of lake-effect snow; Effects of heavy snowfall during December 1989 in the Lake Erie Snowbelt; Comparison of Great Lakes winter severity and ice cover -- Winter 1990 vs. the historical record; Use of aeration to prevent ice buildup at gaging station controls; Restigouche river ice project; Lake Ontario Winter Storms (LOWS) project; Regional snowfall intensity and the Great Lakes anomaly; Annual balance of North Cascade, Washington glaciers predicted from climatic records. GRA

N91-24662# Meteorological Satellite Center, Tokyo (Japan).
CHARACTERISTICS OF GMS-4 VISSR
Yoshishige Shirakawa and Masayuki Sasaki *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 1-10 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

N91-24663# Meteorological Satellite Center, Tokyo (Japan).
INFLUENCE OF THE POLAR ATMOSPHERE ON THE IMAGE MAPPING USING EARTH EDGE DATE
Seiichiro Kigawa *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 11-17 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

N91-24673*# Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences.
THERMAL ANALYSIS OF CONCEPTUAL DESIGNS FOR GPHS/FPSE POWER SYSTEMS OF 250 We AND 500 We Final Report
Thomas J. McComas and Edward T. Dugan Mar. 1991 146 p
(Grant NAG3-1123)
(NASA-CR-187145; NAS 1.26:187145) Avail: NTIS HC/MF A07 CSCL 10B

Thermal analyses were performed for two distinct configurations of a proposed space nuclear power system which combines General Purpose Heat Source (GPHS) modules with the state of the art Free-Piston Stirling Engines (FPSEs). The two configurations correspond to systems with power levels of 250 and 500 W(sub e). The 250 W(sub e) GPHS/FPSE power system utilizes four GPHS modules and one FPSE, and the 500 W(sub e) contains eight GPHS modules and two FPSEs. The configurations of the systems and the bases for selecting the configurations are described. Brief introductory sections are included to describe the GPHS modules and free piston Stirling engines. The primary focus of the thermal analyses is on the temperature of the iridium fuel clad within the GPHS modules. A design goal temperature of 1573 K was selected as the upper limit for the fuel clad during normal operating conditions. The basis for selecting this temperature limit is discussed in detail. Results obtained from thermal analysis of the 250 W(sub e) GPHS/FPSE power system indicate fuel clad temperatures which slightly exceed the design goal temperature of 1573 K. The results are considered favorable due to the numerous conservative assumptions used in developing the thermal model and performing the thermal analysis. To demonstrate the effects of the conservatism, a brief sensitivity analysis is performed in which a few of the key system parameters are varied to determine their effect on the fuel clad temperatures. It is concluded that thermal analysis of a more detailed thermal model would be expected to yield fuel clad temperatures below the design foal temperature limiy 1573 K. Author

N91-24674# Tecogen, Inc., Waltham, MA.
INTEGRATED NATURAL GAS ENGINE COOLING JACKET VAPOR COMPRESSOR PROGRAM Final Report, Feb. 1985 - Aug. 1990
F. A. DiBella Aug. 1990 137 p
(Contract GRI-5084-233-1057)
(PB91-144576; TR4369-065-90; GRI-90/0234) Avail: NTIS HC/MF A07 CSCL 10B

A unique, alternative cogeneration system was designed that provides an industrial or commercial energy user with high pressure steam and electricity directly from a packaged cogeneration system. The Integrated Gas Engine Vapor Compression System concept includes an engine-generator set and a twin screw compressor that are mechanically integrated with the engine. The gas-fueled engine is ebulliently cooled, thus, allowing its water jacket heat to be recovered in the form of low-pressure steam. The steam is

then compressed by the steam compressor to higher pressure, and when combined with the high pressure steam generated in the engine's exhaust gas boiler, it provides the end user with a more usable thermal energy source. Various aspects of the program are discussed. GRA

N91-24675# EG and G Energy Measurements, Inc., Idaho Falls.
ADVANCED BINARY GEOTHERMAL POWER PLANTS: LIMITS OF PERFORMANCE
C. J. Bliem and G. L. Mines Jan. 1991 43 p
(Contract DE-AC07-76ID-01570)
(DE91-010065; EGG-EP-9207) Avail: NTIS HC/MF A03

The Heat Cycle Research Program is investigating potential improvements to power cycles utilizing moderate temperature geothermal resources to produce electrical power. Investigations have specifically examined Rankine cycle binary power systems. Binary Rankine cycles are more efficient than the flash steam cycles at moderate resource temperature, achieving a higher net brine effectiveness. At resource conditions similar to those at the Heber binary plant, it has been shown that mixtures of saturated hydrocarbons (alkanes) or halogenated hydrocarbons operating in a supercritical Rankine cycle gave improved performance over Rankine cycles with the pure working fluids executing single or dual boiling cycles or supercritical cycles. Recently, other types of cycles have been proposed for binary geothermal service. The feasible limits on efficiency of a plant given practical limits on equipment performance is explored and the methods used in these advanced concept plants to achieve the maximum possible efficiency are discussed. (Here feasible is intended to mean reasonably achievable and not cost effective.) No direct economic analysis was made because of the sensitivity of economic results to site specific input. The limit of performance of three advanced plants were considered. The performance predictions were taken from the developers of each concept. The advanced plants considered appear to be approaching the feasible limit of performance. Ultimately, the plant designer must weigh the advantages and disadvantages of the the different cycles to find the best plant for a given service. In addition, a standard is presented of comparison of the work which has been done in the Heat Cycle Research Program and in the industrial sector by Exergy, Inc. and Polythermal Technologies. DOE

N91-24676# California Univ., Berkeley. Lawrence Berkeley Lab.
ENERGY CONVERSION AND STORAGE PROGRAM
Dec. 1990 31 p
(Contract DE-AC03-76SF-00098)
(DE91-010221; LBL-28737-Rev) Avail: NTIS HC/MF A03

The Energy Conversion and Storage Program applies chemical and chemical engineering principles to solve problems in (1) production of new synthetic fuels; (2) development of high-performance rechargeable batteries and fuel cells; (3) development of advanced thermochemical processes for energy storage; (4) characterization of complex chemical processes; and (5) the application of novel materials for energy conversion and transmission. Projects focus on transport-process principles, chemical kinetics, thermodynamics, separation processes, organic and physical chemistry, and advanced methods of analysis. The following five areas are discussed: electrochemical energy storage and conversion; microstructured materials; biotechnology; fossil fuels; and high temperature superconducting processing. Papers have been processed separately for inclusion on the data base. DOE

N91-24677# Energy Technology Data Exchange, Oak Ridge, TN.
INTERNATIONAL ENERGY: RESEARCH ORGANIZATIONS, 1986 - 1990
P. Hendricks, ed. and S. Jordan, ed. Mar. 1991 850 p Sponsored by DOE
(DE91-006224; ETDE/PUB-3) Avail: NTIS HC/MF A99

The International Energy: Research Organizations publication contains the standardized names of energy research organizations used in energy information databases. Involved in this cooperative task are (1) the technical staff of the USDOE Office of Scientific and Technical Information (OSTI) in cooperation with the member countries of the Energy Technology Data Exchange (ETDE), and (2) the International Nuclear Information System (INIS). This publication identifies current organizations doing research in all energy fields, standardizes the format for recording these organization names in bibliographic citations, assigns a numeric code to facilitate data entry, and identifies report number prefixes assigned by these organizations. These research organization names may be used in searching the databases Energy Science and Technology on DIALOG and Energy on STN International. These organization names are also used in USDOE databases on the Integrated Technical Information System. Research organizations active in the past five years, as indicated by database records, were identified to form this publication. This directory includes approximately 34,000 organizations that reported energy-related literature from 1986 to 1990 and updates the DOE Energy Data Base: Corporate Author Entries. DOE

N91-24678# Lawrence Livermore National Lab., CA.
CALIFORNIA ENERGY FLOW IN 1989
I. Y. Borg and C. K. Briggs Feb. 1991 32 p
(Contract W-7405-eng-48)
(DE91-010012; UCID-18991-89) Avail: NTIS HC/MF A03

California's energy use showed a modest increase (2.2 percent) in 1989 over 1988 which was in keeping with the steady increase in population that the state has experienced annually during the decade. All end-use sectors (residential, commercial, industrial, transportation, etc.) contributed to the growth. The larger demand was met by increased imports of all major fuels. Only electrical imports remained close to 1988 levels, in part due to increased output from Diablo Canyon nuclear plant whose performance exceeded expectations. California's per capita energy consumption has traditionally been below the national average due to the relatively benign climate associated with its centers of population. The largest single use for energy in the state was for transportation, which overtook industrial usage in the 60's. Use of highway fuels continued to grow and reached all time highs in 1989. Highway congestion, a major problem and concern in the state, is anticipated to grow as the number of licensed drivers increases; in 1989 the increase was 3.4 percent. Output from the The Geysers Geothermal fields, the largest in the world, continued to falter as the steam output fell. Nonetheless new resources at the Coso Geothermal Resource Area and at the Wendel Geothermal field came on line during the year, and other geothermal areas were under active development. Novel sources of renewable energy (solar, wind, etc.) grew; however, collectively they made only a small contribution to the overall energy supply. Cogenerated electricity sold to the utilities by small power producers inexplicably fell in 1989 although estimates of the total capacity available rose. Energy flow diagrams illustrate energy sources and energy consumption. DOE

N91-24679# Pacific Northwest Lab., Richland, WA.
IMPLICATIONS OF ENVIRONMENTAL EXTERNALITIES ASSESSMENTS FOR SOLAR THERMAL POWERPLANTS
A. D. Lee and M. C. Baechler Mar. 1991 10 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, 17-22 Mar. 1991
(Contract DE-AC06-76RL-01830)
(DE91-010198; PNL-SA-18874; CONF-910318-15) Avail: NTIS HC/MF A02

Externalities are those impacts of one activity on other activities that are not priced in the marketplace. An externality is said to exist when two conditions hold: (1) the utility or operations of one economic agent, A, include nonmonetary variables whose values are chosen by another economic agent, B, without regard to the effects on A, and (2) B does not pay A compensation equal to the incremental costs inflicted on A. Electricity generation involves a wide range of potential and actual environmental impacts. Legislative, permitting, and regulatory requirements directly or indirectly control certain environmental impacts, implicitly causing them to become internalized in the cost of electricity generation.

Electricity generation, however, often produces residual environmental impacts that meet the definition of an externality. Mechanisms have been developed by several states to include the costs associated with externalities in the cost-effectiveness analyses of new powerplants. This paper examines these costs for solar thermal plants and applies two states' scoring methodologies to estimate how including externalities would affect the levelized costs of power from a solar plant in the Pacific Northwest. It concludes that including externalities in the economics can reduce the difference between the levelized cost of a coal and solar plant by between 0.74 and 2.42 cents/kWh. DOE

N91-24680# Department of Energy, Washington, DC. Office of Energy Markets and End Use.
ANNUAL ENERGY OUTLOOK 1991 WITH PROJECTIONS TO 2010
Mar. 1991 124 p
(DE91-010323; DOE/EIA-0383(91)) Avail: NTIS HC/MF A06

The report examines a range of scenarios by considering and comparing the effects of three selected variations from a reference case. Fundamental forces that determine the direction of energy markets will remain in effect. Recent events and high prices may have some residual impacts on Government policy, industrial energy planners, and consumers. Higher oil prices could stimulate interest in conservation and renewable energy and encourage growth in domestic energy production capacity. United States energy consumption has held steady for the third year in a row. Oil imports increased and use of electrical power increased. Legislative initiatives could set in motion significant changes in energy markets world wide. A proposed National Energy Strategy has primary goals of economic growth, energy security and environmental improvement. Energy resources and energy uses of the United States are discussed. Energy resources include petroleum, natural gas, coal, and renewable energy sources. Statistical data is presented in various tables and graphs for energy consumption by end use sector. DOE

N31-24681# Oak Ridge National Lab., TN.
TRANSPORTATION ENERGY DATA BOOK
S. C. Davis and P. S. Hu Jan. 1991 314 p
(Contract DE-AC05-84OR-21400)
(DE91-010433; ORNL-6649; ORNL-5198-Ed-11) Avail: NTIS HC/MF A14

The Transportation Energy Data Book: Edition 11 is a statistical compendium prepared and published by Oak Ridge National Laboratory (ORNL) under contract with the Office of Transportation Technologies in the Department of Energy (DOE). Designed for use as a desk-top reference, the data book represents an assembly and display of statistics and information that characterize transportation activity, and presents data on other factors that influence transportation energy use. The purpose of this document is to present relevant statistical data in the form of tables and graphs. Each of the major transportation modes - highway, air, water, rail, pipeline - is treated in separate chapters or sections. Chapter 1 compares U.S. transportation data with data from seven other countries. Aggregate energy use and energy supply data for all modes are presented in Chapter 2. The highway mode, which accounts for over three-fourths of total transportation energy consumption, is dealt with in Chapter 3. Topics in this chapter include automobiles, trucks, buses, fleet automobiles, Federal standards, fuel economies, and household data. Chapter 4 is a new addition to the data book series, containing information on alternative fuels and alternatively-fueled vehicles. The last chapter, Chapter 5, covers each of the nonhighway modes: air, water, pipeline, and rail, respectively. DOE

N91-24651# Fokker B.V., Schipol-Oost (Netherlands).
SOLAR ARRAY QUALIFICATION THROUGH QUALIFIED ANALYSIS
J. Zijdemans, H. J. Cruijssen, and J. J. Wijker *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 11 p
(For primary document see N91-24638 16-39)
Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-25059*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AN OVERVIEW OF THE FIRST RESULTS ON THE SOLAR ARRAY PASSIVE LDEF EXPERIMENT (SAMPLE), AO171 Abstract Only
Ann F. Whitaker and Leighton E. Young *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 93 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

N91-25060*# Air Force Aero Propulsion Lab., Wright-Patterson AFB, OH. Aerospace Power Div.
EXPERIMENT M0003-4: ADVANCED SOLAR CELL AND COVERGLASS ANALYSIS, AN OVERVIEW Abstract Only
Terry M. Trumble *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 94 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

N91-25061*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED PHOTOVOLTAIC EXPERIMENT, S0014: PRELIMINARY FLIGHT RESULTS AND POST-FLIGHT FINDINGS Abstract Only
David J. Brinker, John R. Hickey (Eppley Lab., Inc., Newport, RI.), and Donald K. Brasted *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 95 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

N91-25062*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DURABILITY EVALUATION OF PHOTOVOLTAIC BLANKET MATERIALS EXPOSED ON LDEF TRAY S1003 Abstract Only
Sharon K. Rutledge and Raymond M. Olle (Cleveland State Univ., OH.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 96 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

N91-25063*# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Space Communications and Propulsion Div.
LONG DURATION EXPOSURE FACILITY (LDEF) RESULTS Abstract Only
Ludwig Preuss *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 97 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

N91-25072*# Optical Coating Lab., Inc., Santa Rosa, CA.
OPTICAL PERFORMANCE OF EXPOSED SOLAR CELL COVERS Abstract Only
Bryant P. Hichwa, Steven R. Selee, Jerry Dodds, and Greg S. Long *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 106 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

N91-25092*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
LONG DURATION EXPOSURE FACILITY (LDEF) LOW-TEMPERATURE HEAT PIPE EXPERIMENT PACKAGE (HEPP) POWER SYSTEM RESULTS Abstract Only
Smith E. Tiller and David Sullivan *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 126 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10B

45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

N91-24682# Acurex Corp., Mountain View, CA. Environmental Systems Div.
NOx EMISSION CONSTRAINTS ON HIGH-TEMPERATURE PROCESSES Final Report, Apr. 1988 - Nov. 1990
R. A. Brown, H. B. Mason, J. A. Nicholson, and C. I. Okoh Nov. 1990 83 p
(Contract GRI-5087-233-1578; GRI Proj. 8059)
(PB91-136424; GRI-90/0276) Avail: NTIS HC/MF A05 CSCL 13B

Current and emerging NOx emission regulations were reviewed to identify possible constraints on high-performance burner application in industrial furnaces. Industrial furnace regulations were evaluated for new and existing sources in air quality attainment and non-attainment areas. Processes emphasized were ferrous and nonferrous metals heating and heat-treating furnaces, glass melting furnaces, and mineral kilns. Regulation of best available control technology (BACT) for new sources is projected to impact process furnaces the most. Metal reheating furnaces, glass melting furnaces, and kilns will be the most susceptible to BACT. Nonferrous melting forging furnace and soaking pits will not be seriously constrained by BACT. Author

N91-24683# Oak Ridge National Lab., TN. Environmental Sciences Div.
ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM: ECOLOGICAL INDICATORS
Carolyn T. Hunsaker, ed. and Dean E. Carpenter (NSI Technology Services Corp., Research Triangle Park, NC.) Sep. 1990 432 p
(Contract EPA-68-02-4444)
(PB91-141796; EPA/600/3-90/060) Avail: NTIS HC/MF A19 CSCL 13B

The Environmental Protection Agency's (EPA's) Office of Research and Development initiated the Environmental Monitoring and Assessment Program (EMAP) to provide data for better assessments of the condition of the nation's ecological resources. Over the next five years, several integrated monitoring networks will be implemented to: (1) estimate current status, extent, changes, and trends in indicators of ecological condition; (2) monitor indicators of pollutant exposure and habitat condition and seek associations among indicators that provide plausible explanations for adverse condition; and (3) provide periodic reports on status and trends to the EPA Administrator and the public. These networks will yield statistically unbiased estimates with quantifiable confidence limits on regional and national scales for periods of years to decades. The report presents the approach proposed to describe ecological condition; defines a common strategy within the program for selecting, prioritizing, and evaluating indicators chosen for evaluation as core indicators, which will be implemented in regional and national monitoring of six categories of resources: near-coastal waters, inland surface waters, wetlands, forests, arid lands, and agroecosystems. GRA

N91-24684# NSI Technology Services Corp., Corvallis, OR.
PROJECTION OF RESPONSE OF TREES AND FORESTS TO ACIDIC DEPOSITION AND ASSOCIATED POLLUTANTS
A. Ross Kiester, E. David Ford, Anne Avery, Cheryl Gay, Terry Droessler, Susan Bassow, Steven Cothern, and Kristin Sorrensen (Washington Univ., Seattle.) Sep. 1990 222 p Sponsored by EPA
(PB91-136572; EPA/600/3-90/096) Avail: NTIS HC/MF A10 CSCL 13B

In 1986 the National Acid Precipitation Assessment Program (NAPAP) established the Forest Response Program (FRP) to assess the effects of acidic deposition and associated pollutants on forests. Modeling studies were developed in parallel with both field studies on the pattern and trends of forest condition and physiological studies of seedlings, saplings, and branches of mature trees. The goals of the modeling effort were to simulate the dynamics of the processes by which acidic deposition and ozone affect tree physiological processes and therefore lead to changes in growth. Results from models of the physiological function of leaves, branches, roots, xylem, and canopies are presented. Author

N91-24685*# North Carolina State Univ., Raleigh. Dept. of Chemical Engineering.
HETEROGENEOUS PHOTOCATALYTIC OXIDATION OF ATMOSPHERIC TRACE CONTAMINANTS Semiannual Progress Report No. 1, 11 Jan. 1990 - 30 Apr. 1991
David F. Ollis and Jose Peral 15 May 1991 37 p
(Grant NAG2-684)
(NASA-CR-188200; NAS 1.26:188200) Avail: NTIS HC/MF A03 CSCL 13B

The following subject areas are covered: (1) design and construction of continuous flow photoreactor for study of oxidation of trace atmospheric contaminants; (2) establishment of kinetics of acetone oxidation including adsorption equilibration, variation of oxidation rate with acetone concentration and water (inhibitor), and variation of rate and apparent quantum yield with light intensity; (3) exploration of kinetics of butanol oxidation, including rate variation with concentration of butanol, and lack of inhibition by water; and (4) exploration of kinetics of catalyst deactivation during oxidation of butanol, including deactivation rate, influence of dark conditions, and establishment of photocatalytic regeneration of activity in alcohol-free air. Author

N91-24686*# Environmental Dynamics Research, Inc., Palm Beach Gardens, FL.
THE IMPACT OF GREENHOUSE CLIMATE CHANGE ON THE ENERGETICS AND HYDROLOGIC PROCESSES OF MID-LATITUDE TRANSIENT EDDIES
Lee E. Branscome and William J. Gutowski, Jr. (Atmospheric and Environmental Research, Inc., Cambridge, MA.) May 1991 40 p
(Grant NAG8-656)
(NASA-CR-188203; NAS 1.26:188203) Avail: NTIS HC/MF A03 CSCL 13B

Atmospheric transient eddies contribute significantly to mid-latitude energy and water vapor transports. Changes in the global climate, as induced by greenhouse enhancement, will likely alter transient eddy behavior. Unraveling all the feedbacks that occur in general circulation models (GCMs) can be difficult. The transient eddies are isolated from the feedbacks and are focused on the response of the eddies to zonal-mean climate changes that result from CO2-doubling. Using a primitive-equation spectral model, the impact of climate change on the life cycles of transient eddies is examined. Transient eddy behavior in experiments is compared with initial conditions that are given by the zonal-mean climates of the GCMs with current and doubled amounts of CO2. The smaller meridional temperature gradient in a doubled CO2 climate leads to a reduction in eddy kinetic energy, especially in the subtropics. The decrease in subtropical eddy energy is related to a substantial reduction in equatorward flux of eddy activity during the latter part of the life cycle. The reduction in equatorward energy flux alters the moisture cycle. Eddy meridional transport of water vapor is shifted slightly poleward and subtropical precipitation is reduced. The water vapor transport exhibits a relatively small change in magnitude, compared to changes in eddy energy, due to the compensating effect of higher specific humidity in the doubled-CO2 climate. An increase in high-latitude precipitation is related to the poleward shift in eddy water vapor flux. Surface evaporation amplifies climatic changes in water vapor transport and precipitation in the experiments. Author

N91-24687# Federal Coordinating Council for Science, Engineering and Technology, Washington, DC. Committee on Earth and Environmental Sciences.
OUR CHANGING PLANET: THE FY 1991 RESEARCH PLAN OF THE US GLOBAL CHANGE RESEARCH PROGRAM
Oct. 1990 266 p
(PB91-145813) Avail: NTIS HC/MF A12 CSCL 13B

The research planning for the U.S. Global Change Research Program for fiscal year (FY) 1991 is emphasized. It is the second in a series of such documents that facilitates the coordination of the program and reflects the research and integrated budget planning processes of the Working Group on Global Change of the Committee on Earth and Environmental Sciences (CEES). These research planning and budgetary activities are extended through FY 1991. The key emphasis in FY 1991 is on establishing the research required to provide the scientific information needed as input to current environmental policy issues, e.g., stratospheric ozone depletion and climate change, including greenhouse warming. The opening sections summarize the following: (1) these policy needs in the context of global change science; (2) the planning of the research program to address them; and (3) the benefits to be accrued from the enhanced understanding. GRA

N91-24688# Environmental Protection Agency, Research Triangle Park, NC. Atmospheric Research and Exposure Assessment Lab.

ATMOSPHERIC TRANSPORT AND DEPOSITION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS

R. A. Hites and R. L. Harless Jan. 1991 123 p Prepared in cooperation with Indiana Univ., Bloomington

(PB91-144667; EPA/600/3-91/002) Avail: NTIS HC/MF A06 CSCL 13B

The goal of the project was to sudy polychlorinated dibenzo p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in ambient air and rain samples in an effort to enhance the understanding of the physical/chemical parameters controlling the transformations which take place during atmospheric transport and deposition. Analytical methods included high volume air sampling, wet-only rain sampling, column chromatographic cleanup, and an electron capture, negative ionization form of gas chromatographic mass spectrometry. Air and rain samples were divided into vapor phase and particle bound or dissolved and particle bound fractions, respectively. The results showed that the total concentrations of PCDD and PCDF in Bloomington, Indiana, have a geometric standard deviation range from 1.4 to 4.4 pg/cu m in air and from 63 to 220 pg/L in rainwater. The vapor to particle ratio for individual congeners ranged from 0.01 to 30. The ratio is controlled by the individual congener's vapor pressure and the ambient air temperature. Estimates of washout and the Henry's law constants were obtained using average ambient air and rain data. GRA

N91-24689# World Meteorological Organization, Geneva (Switzerland).

SCIENTIFIC ASSESSMENT OF CLIMATE CHANGE. THE POLICYMAKERS' SUMMARY OF THE REPORT OF WORKING GROUP 1 TO THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Jul. 1990 29 p Original contains color illustrations

Avail: NTIS HC/MF A03

The following subject areas are covered: what factors determine global climate; what are the greenhouse gases and why are they increasing; which gases are the most important; how much is climate expected to change; has man already begun to change the global climate; how much will sea level rise; and what will be the effect of climate change on ecosystems. Author

N91-24690# Executive Office of the President, Washington, DC. Committee on Earth and Environmental Sciences.

OUR CHANGING PLANET: THE FY 1992 US GLOBAL CHANGE RESEARCH PROGRAM. A SUPPLEMENT TO THE US PRESIDENT'S FISCAL YEAR 1992 BUDGET

1991 102 p

Avail: NTIS HC/MF A06

The central goal of the U.S. Global Change Research Program is to establish the scientific basis in support of national and international policymaking relating to natural and human-induced changes in the global Earth system by: (1) establishing an integrated, comprehensive, long-term program of documenting the Earth system on the global scale; (2) conducting program of focused studies to improve the understanding of the physical, geological, chemical, biological, and social processes that influence Earth system processes; and (3) developing integrated conceptual and predictive Earth system models. Author

N91-24691# Lawrence Livermore National Lab., CA.

NO(x) POLLUTION FROM BIOMASS BURNING: A GLOBAL STUDY

J. Dignon, C. S. Atherton, J. E. Penner, and J. J. Walton 14 Mar. 1991 10 p Presented at the 11th Conference on Fire and Forest Meteorology, Missoula, 16-19 Apr. 1991

(Contract W-7405-eng-48)

(DE91-010154; UCRL-JC-104735; CONF-9104207-1) Avail: NTIS HC/MF A02

Estimates are presented of nitrogen oxide NO(x) emission from worldwide biomass burning totaling approx. 13 Tg N/yr on a degree longitude by 1 deg latitude grid. Roughly 80 pct of these emissions occur in the zone from 25 deg N to 25 deg S. The inventory presented here is compared with other published estimates as well as the additional known sources of atmospheric NO(x). The emission results presented here are used in a 3-D chemical transport model. Model simulations suggest that America and southeast Asia which are comparable to those of Northern Hemisphere industrialized regions. DOE

N91-24692# Wyoming Univ., Laramie. Dept. of Geography and Recreation.

SIMULATION OF LANDSCAPE DISTURBANCES AND THE EFFECT OF CLIMATIC CHANGE

W. L. Baker Apr. 1991 87 p

(Contracts DE-FG02-90ER-60977; DE-FG02-89ER-60883)

(DE91-010191; DOE/ER-60977/1) Avail: NTIS HC/MF A05

The purpose is to understand how changes in climate may affect the structure of landscapes that are subject to periodic disturbances. A general model useful for examining the linkage between climatic change and landscape change was developed. The model makes use of synoptic climatic data, a geographical information system (GRASS), field data on the location of disturbance patches, simulation code written in the SIMSCRIPT language, and a set of landscape structure analysis programs written specifically for this research project. A simplified version of the model, lacking the climatic driver, was used to analyze how changes in disturbance regimes (in this case settlement and fire suppression) affect landscape change. Landscape change lagged in its response to changes in the disturbance regime, but the lags differed depending upon the character of the change and the particular measure considered. The model will now be modified for use in a specific setting to analyze the effects of changes in climate on the structure of flood-disturbed patches along the Animas River, Colorado. DOE

N91-24693# Oak Ridge National Lab., TN.

MULTIPLE-AIRCRAFT INSTANTANEOUS LINE SOURCE (MAILS) DISPERSION MODEL USER'S GUIDE

E. J. Liebsch Mar. 1991 61 p

(Contract DE-AC05-84OR-21400)

(DE91-010448; ORNL/TM-11649) Avail: NTIS HC/MF A04

Instructions are provided for the use of the Multiple-Aircraft Instantaneous Line Source (MAILS) atmospheric-dispersion model. MAILS is intended as a screening model for prediction of air quality impacts of air pollution emissions from low flying aircraft on military training routes (MTRs). An air quality screening model is generally defined as one that provides worst-case concentration estimates and can be run quickly with a minimum of user input. The MAILS model predictions of pollutant concentrations are considered to be worst case estimates because of the assumptions incorporated in the model design. DOE

46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

N91-24694 Princeton Univ., NJ.
LOW-FREQUENCY VARIABILITY AND THE INSTABILITY OF ZONALLY VARYING ATMOSPHERIC FLOWS Ph.D. Thesis
Jeffrey Lowe Anderson 1990 245 p
Avail: Univ. Microfilms Order No. DA9104345

The instability of the barotropic vorticity equation on the sphere, linearized about a zonally varying, time-mean basic state, was examined by Simmons et al (1983). They demonstrated similarities between the most unstable eigenmodes of this problem and patterns of low frequency variability in the atmosphere. Although empirical evidence for this relation is suggestive, no satisfactory physical explanation of the mechanism involved has been proffered. The sensitivity of this eigenvalue problem to changes in parameters of the barotropic model is studied. The sensitivity of the unstable nodes with respect to changes in resolution, in the basic state, and in diffusion are presented. Since the observed atmospheric state does not satisfy the vorticity equation, a forcing term is assumed to balance the basic state time tendency for the eigenvalue problem. Three infinite beta plane models are used to gain insight into the validity of this assumption. The first investigates instabilities of finite amplitude, stationary Rossby waves of arbitrary orientation. The second examines instabilities of finite amplitude, stationary baroclinic Rossby waves of arbitrary orientation in a two level model with zonal shear. Finally, a forced barotropic model, linearized about the upper level basic state from the two level model, is examined. Nearly stationary states of the barotropic vorticity equation on the sphere close to observed states of the atmosphere are produced using minimization algorithms.
Dissert. Abstr.

N91-24695 Washington Univ., Seattle.
TRACER TRANSPORT IN THE STRATOSPHERE DEDUCED FROM SATELLITE DATA AND A TWO-DIMENSIONAL MODEL Ph.D. Thesis
Woo Kap Choi 1990 230 p
Avail: Univ. Microfilms Order No. DA9104212

The effective transport velocity (e.g., the meridional circulation that can produce the observed seasonal variations in the tracer fields) is estimated from both observed tracer distributions and model simulations in the stratosphere. The equatorial double peak structure is emphasized among other features of tracer mixing ratio fields to validate the transport velocity. Three years of zonally averaged N2O and CH4 data from the SAMS instrument on Nimbus 7 are utilized to investigate the annual and semiannual cycles in long-lived tracer mixing ratios. The annual and semiannual variations are shown to be approximately antisymmetric and symmetric about the equator, respectively. Using the first three components of the cycles to estimate the time tendency, the tracer continuity equation is solved diagnostically to obtain the effective transport velocity. A two dimensional isentropic coordinate model is constructed for further study. The meridional velocities and horizontal diffusion coefficients are calculated from the net radiative heating and the x-momentum equation respectively. The tracer continuity equation is integrated in time for N2O by using the diabatic circulation and diffusion coefficients. To intensify the equinoctial subsidence, the climatological zonal mean wind and corresponding temperature fields are modified by using a stronger semiannual oscillation in the equatorial region. Thus, the new vertical velocity fields produced change in the resulting tracer patterns.
Dissert. Abstr.

N91-24696 Cornell Univ., Ithaca, NY.
ALFVEN WAVES AND STATIC FIELDS IN MAGNETOSPHERE/IONOSPHERE COUPLING: IN-SITU MEASUREMENTS AND A NUMERICAL MODEL Ph.D. Thesis
David J. Knudsen 1990 212 p
Avail: Univ. Microfilms Order No. DA9106303

Perturbation electric and magnetic fields carry in excess of 10(exp 10) to 10(exp 12) W of electrical power between the magnetosphere and high-latitude ionosphere. Most of this power is generated by the solar wind. The energy transferred to the ionosphere by time-varying electromagnetic fields in the form of Alfven waves is more difficult to calculate because density and conductivity gradients can reflect energy. Thus, field resonances and standing wave patterns affect the magnitude and altitude distribution of electrical energy dissipation. A numerical model was used to calculate the frequency-dependent electric field reflection coefficient of the ionosphere and show that the ionosphere does not behave as a simple resistive slab for electric field time scales less than a few seconds.
Dissert. Abstr.

N91-24697 Cornell Univ., Ithaca, NY.
IONOSPHERIC PROCESSES ASSOCIATED WITH INTENSE SUBAURORAL ELECTRIC FIELDS Ph.D. Thesis
James Fred Providakes 1990 285 p
Avail: Univ. Microfilms Order No. DA9106307

Observations of ionospheric parameters were made near an equatorward edge of the auroral oval. Using both experimental data and theory, the ionospheric response to substorm related intense localized electric fields at subauroral latitudes is discussed. A deep depletion in the ionospheric electron density was found to be colocated with these large electric fields at magnetic latitudes as low as 53 deg. It is shown that the associated field aligned currents are very weak in this region and that it is the F region structure which dominates the conductivity gradient rather than the E region. The experimental data also indicate that the trough develops much more quickly than present theories predict, at least near the F peak. It is also shown that when a sheared or turbulent velocity field is present within a scattering volume, the scatter radar spectra will be distorted. Two different cases (large scale velocity shear and small scale turbulent velocity fluctuations) are studied and the theory is compared with observed distorted spectra obtained in scattering volumes known from in situ data to contain perpendicular velocity fluctuations. Results are discussed.
Dissert. Abstr.

N91-24698 Pennsylvania State Univ., University Park.
THE MESOSCALE RESPONSES OF A LOCALLY HEATED PLANETARY BOUNDARY LAYER Ph.D. Thesis
Peter John Sousounis 1990 175 p
Avail: Univ. Microfilms Order No. DA9104973

The steady boundary layer responses that occur over the Great Lakes region during wintertime cold air outbreaks are examined using a 2-D, linear, analytic model. The boundary layer is modeled as an idealized, constantly stratified, viscous, rotating Boussinesq fluid that move uniformly between two horizontally infinite, rigid, stress free plates. The heat from the lakes is parameterized in terms of a diabatic forcing function. Solution of the governing differential equation yields an integral expression for the vertical motion of the general response. Further assessment of the response is gained by examining closed form analytic solutions to several limiting cases. Four response types are identified that depend on the values of the Froude number, the Ekman number, the thermal Ekman number, and the eddy Prandtl number. Results from the study show the significant effects of rotation, stability, mean flow speed, heating dimensions, and friction on the thermal response of a uniformly moving layer of fluid. Implications of the model results to the boundary layer responses that occur over the Great Lakes region during wintertime cold air outbreaks are presented.
Dissert. Abstr.

N91-24699# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
LINEAR STABILITY OF WAVY BAROCLINIC FLOW OVER TOPOGRAPHY M.S. Thesis
Thomas F. Simeone 1990 116 p
(AD-A232758; AFIT/CI/CIA-90-144) Avail: NTIS HC/MF A06 CSCL 04/1

Topography plays an important role in forcing planetary scale stationary waves as well as influencing synoptic scale disturbances.

The purpose of this thesis is to investigate topographic influences on planetary and synoptic scale waves in a baroclinic fluid using the quasi-geostrophic potential vorticity equation with wavenumber two bottom topography and a steady, wavy basic state on an f-plane. The steady basic state is sinusoidal in x with linear vertical shear and represents an exact solution to the quasi-geostrophic potential vorticity equation and thermodynamic equations at the upper and lower boundaries. The amplitude of the wavy basic is highly dependent on forcing by a constant zonal flow, U sub o. U sub o is a parameter used to represent momentum flux convergence into the mid-latitudes. The results from a linear analytical solution show that any mode with wavenumber n which interacts with the two-wave topography will introduce two additional modes, n+2. All three modes will have the same frequency. The results of a linear stability analysis from a numerical model show that the growth rate for the most unstable mode is not highly dependent on the mountain height or zonal flow, U sub o. When there is a wavy basic state forced by U sub o, the perturbations are forced to follow the basic state. When U sub o is zero, there is no wavy basic state; however, the perturbations still are forced to wave over the mountain. GRA

N91-24700# Nielsen Engineering and Research, Inc., Mountain View, CA.
ADVANCED METHODS FOR ATMOSPHERIC MODELING Final Report, 1 Jul. - 31 Dec. 1990
Laura C. Rodman 31 Jan. 1991 45 p
(Contract F49620-90-C-0040)
(AD-A232966; NEAR-TR-420; AFOSR-91-0052TR) Avail: NTIS HC/MF A03 CSCL 04/1

The evolution of physical processes in a numerical simulation of the atmosphere and the effects of their interactions on a forecast are very complex and difficult to isolate. An analysis was developed which uses artificial intelligence techniques to study the time-evolving quantities in a numerical simulation in order to determine the relationships among various flow parameters. This procedure was divided into two parts. First, the data was manipulated into a form that allowed the relationships of interest to be isolated. In particular, it was necessary to be able to see how several quantities may interact to affect the solution. The next step used an expert system to analyze the data based on the relationships. The test problem chosen was the numerical simulation of the decay of turbulence in a stratified fluid. Three different analyses were used to determine sensitivities, comparisons, and correlations among the flow quantities. The automation of this technique allowed the processing of the large amounts of data that were generated by a numerical simulation. For the test case, this method was able to draw similar conclusions about the nature of the flow solution compared with those given in the literature. GRA

N91-24701# SRI International Corp., Menlo Park, CA. Geoscience and Engineering Center.
MITHRAS STUDIES OF THE AURORAL OVAL AND POLAR CAP Final Report, 1 May 1987 - 31 Dec. 1990
Odile DelaBeaujardiere, Juergen Watermann, and Robert M. Johnson Jan. 1991 48 p
(Contract F49620-87-K-0007)
(AD-A232975; SRI-ESU-3573; AFOSR-91-0058TR) Avail: NTIS HC/MF A03 CSCL 04/1

MITHRAS is a program of coordinated experiments dedicated to studying the coupling between the magnetosphere, the ionosphere, and the thermosphere. MITHRAS observations mostly involve the Sondrestrom radar in Greenland, but other incoherent scatter radars around the world were also used. Contract highlights include the following items. (1) The most extensive comparisons ever made between incoherent scatter radar data and numerical simulation models were performed. These comparisons were based on both individual case studies and averaged data, and included observations from all the incoherent scatter radars. The comparisons showed general agreement between observations and model calculations but they also showed significant differences. (2) During solar maximum conditions, the contribution to the height integrated Pederson conductivity from solar produced F-region ionization can be as large as 60 pct. of the total. (3) Under certain geophysical conditions it appears possible to identify the low altitude cusp and distinguish it from the cleft. The cusp proper appears to be characterized by enhanced F region plasma density collocated with elevated F region electron temperature; it does not appear to be associated with a particular plasma flow pattern signature. (4) A new mechanism was proposed to explain how auroral surges might be formed. It was suggested that the surge was associated with a distortion of the poleward boundary of the aurora, and that this distortion was caused by the field aligned current. GRA

N91-24702# Leicester Univ. (England). Dept. of Physics.
STUDIES OF PLASMA IRREGULARITIES AND CONVECTION IN THE POLAR IONOSPHERE USING HILAT, SABRE AND EISCAT Final Report, Aug. 1987 - 31 Mar. 1990
Tudor B. Jones and Mark Leicester 31 Dec. 1990 39 p
(Grant AF-AFOSR-0322-87)
(AD-A232983; AFOSR-87-0322TR; EOARD-TR-91-04) Avail: NTIS HC/MF A03 CSCL 04/1

The average ionospheric convection patterns measured by SABRE as a function of IMF Bz and By were computed. The convection of SABRE geomagnetic latitudes about 61 to 66 N is seen to be stronger during negative Bz. Asymmetries in the convection pattern are detected as a function of By. The nightside flow reversal is found to occur at earlier local times for positive By. The duration of purely equatorward flow in this reversal region is found to be longer during intervals of negative By. Although there are only a few clear examples, the ionospheric convection associated with the morning reversal, i.e., the cusp region, it also dependent upon the sign of By. A period of anomalous westward flow occurs at the higher latitudes prior to the reversal during positive By conditions. The occurrence of backscatter during the complete interval of SABRE operations was also investigated. Relating the mean daily backscatter power with various interplanetary parameters such as vBz, v-sq Bz and epsilon indicates that the sign of Bz is the most important parameter. The mean power is considerably higher during intervals of southward Bz. A study which attempted to relate the occurrence of E-region irregularities to the location of the F-region trough was undertaken. No clear relationship appears to exist between these two phenomena based upon data from SABRE and EISCAT taken over a 36 month interval. Finally, the height of the E-region irregularities measured with the SADIE system was investigated. GRA

N91-24703# Gifford (F. A.), Oak Ridge, TN.
THE STRUCTURE OF ATMOSPHERIC DIFFUSION AT REGIONAL SCALES Final Technical Report, 1 Jul. - 31 Dec. 1990
Franklin A. Gifford 31 Jan. 1991 38 p
(Contract DAAL03-90-C-0018)
(AD-A233153; ARO-27096.1-GS-S) Avail: NTIS HC/MF A03 CSCL 24/1

The NOAA/ACURATE data, nineteen-month long series of 12-hour averaged Kr-85 air-concentration measurements at five sites up to 1050 km downwind of a source near AIKEN, SC., are analyzed by a technique of fractal geometry, the renormalized range statistic R/S. Fractional Brownian motion (Hurst) exponents H equal to about 0.35 are found for atmospheric eddy sizes of several hundred km, the entrophy-cascade range, and these increased to H-values of about 0.45 for larger scale motions. Corresponding fractal dimensions, D, equal about 1.65 and 1.55. Related power spectra and autocorrelations are discussed. The fractal indices can be applied in numerical diffusion models using available computer algorithms. Examples of R/S-analysis of short range, rapid response atmospheric diffusion observations are compared with the ACURATE results. GRA

N91-24704# Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
THEORETICAL AND MODELING STUDIES OF THE MARINE PLANETARY BOUNDARY LAYER Annual Report, 15 Dec. 1989 - 14 Dec. 1990
David A. Randall 14 Dec. 1990 4 p
(Contract N00014-89-J-1364)
(AD-A233185) Avail: NTIS HC/MF A01 CSCL 04/1

The research goals were: (1) to gain an improved theoretical understanding of and a predictive capability for partly cloudy boundary layers, and to test these ideas against data acquired in the field and (2) to investigate the role of air-sea interactions in regulating cloud amount in the marine boundary layer. The objectives were to produce an extensive set of theoretical and numerical results, leading to better physical understanding of the cloudy marine boundary layer and provide a theoretical basis for the planning and execution of the Atlantic Stratocumulus Transition Experiment (ASTEX). A new type of boundary-layer model was developed that combines second order closure with a bulk representation of the vertical structure. The boundary-layer depth and turbulence kinetic energy (TKE) are prognostically determined. The large turbulent eddies that are primarily responsible for the fluxes are modeled as convective circulations, with ascending and descending branches. The interior of the boundary layer is bounded above by a thin entrainment layer and below by a thin ventilation layer. Conservative variables such as the the equivalent potential temperature have quadratic profiles in the interior. Convective circulations occur, with rising branches occupying fractional area sigma, which is predicted by the model. The upper ocean is represented by a mixed layer whose depth can be either fixed or variable, depending on the objectives of the numerical experiment being conducted. GRA

N91-24705# Wyoming Univ., Laramie. Dept. of Physics and Astronomy.
AEROSOL OPTICAL PROPERTIES OF THE FREE TROPOSPHERE
James M. Rosen 15 Dec. 1990 14 p
(Contract F19628-90-K-0011)
(AD-A233268; UWY/AP-90/1215; GL-TR-90-0357; SR-1) Avail: NTIS HC/MF A03 CSCL 04/1

During the first year of this research project significant progress was made in assembling and testing a unique set of sensors that will be employed to develop and verify models of aerosol optical properties of the free troposhere. These are balloon borne instruments and include a backscatter sensor, a total scatter sensor and a particle counter for determining size distribution over an extended range. Field measurements were obtained in an experiment of opportunity with other researchers and an unusual data set was obtained that will allow us to start the aerosol model development and testing portion of this research at an earlier date than anticipated. GRA

N91-24706# Boston Univ., MA. Center for Space Physics.
THE DAY-TO-DAY VARIABILITY OF TOTAL CONTENT, PEAK DENSITY AND SLAB THICKNESS, AND THE IONOSPHERIC RESPONSE TO GEOMAGNETIC STORMS Final Report, Jun. 1986 - Sep. 1990
Matthew W. Fox Nov. 1990 69 p
(Contract F19628-86-K-0026)
(AD-A233294; GL-TR-90-0313) Avail: NTIS HC/MF A04 CSCL 04/2

The issue of day-to-day ionospheric is of ongoing concern to users of satellites, navigation systems, and HF radio communications, and the mechanisms behind the variations are of interest to researchers. This report attempts to satisfy those operational concerns with a physical perspective, by analyzing hourly ionospheric data and developing an operationally useful model of the variations discussed in terms of the underlying physical processes. We describe an analysis of day-to-day variations in the total electron content, maximum electron density and equivalent slab thickness using nearly two solar cycles of observations from the American sector at mid latitudes. The report begins by quantifying day-to-day variability of these three F-region parameters and by performing a detailed correlation analysis between them. Usefulness of statistical and persistence forecasts are discussed. Then follows a study of the response of the ionosphere to geomagnetic storms, as these are the times when the variations from day to day are greatest. We then define storm patterns in terms of the departures on each day from average conditions in a storm-affected period. The average ionospheric response under a variety of conditions is described qualitatively and numerically. Individual storm patterns and common storm-related features are studied to characterize each storm and to investigate dependencies and interdependencies. GRA

N91-25077*# Eppley Lab., Inc., Newport, RI.
PASSIVE EXPOSURE OF EARTH RADIATION BUDGET EXPERIMENT COMPONENTS LDEF EXPERIMENT AO-147: POST-FLIGHT EXAMINATIONS AND TESTS Abstract Only
John R. Hickey *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 111 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 04A

47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

N91-24707 California Univ., Berkeley.
SPATIAL AND TEMPORAL CLIMATIC VARIATIONS IN THE TROPICAL ATLANTIC AND THEIR RELATIONSHIPS TO ENSO Ph.D. Thesis
Lee-Chiu Huang 1990 183 p
Avail: Univ. Microfilms Order No. DA9103726

The monthly anomaly data of SST, SLP, and 700 mb height during the period 1946/1947 to 1986/1988 for the Central Atlantic were analyzed by principal component and power spectrum methods. The first three, and sometimes four principal components of both the spatial and temporal patterns of each variable were closely studied in order to define their special space-time features as well as to study the reality of ENSO signals in the Atlantic. The results were used when possible to suggest mechanisms that may be operating to produce the patterns of variation observed and to point out climatic teleconnections within the study area that may be associated with that variability. The results suggest that there are ENSO-like climatic signals in the Atlantic but their spatial and temporal signatures differ from those of the Pacific. An east-west SLP oscillation in the North Atlantic with periodicities of 20, 13, 7.8, 3 to 3.5, and 2.4 years was identified to be concurrent with Pacific ENSO. The patterns of SST in the Atlantic are similar to those of the Pacific during ENSO events but they lag the Pacific ENSO pattern by 6 to 18 months. Dissert. Abstr.

N91-24708 Princeton Univ., NJ.
SEASONAL AND INTERANNUAL VARIABILITY IN THE TROPICAL PACIFIC OCEAN Ph.D. Thesis
Yi Chao 1990 138 p
Avail: Univ. Microfilms Order No. DA9104322

The structure of seasonal and interannual variability in the topical Pacific Ocean is studied. The annual cycle is found to involve a coupled mode which, near the equator, propagates westward with a speed of 50 cm/s and has a wavelength of 15000 km approximately. As in the equatorial Atlantic, the equatorial Pacific has an equilibrium response to the seasonally varying winds. Despite this similarity between the two basins, the current fluctuations are distinctly different. The Pacific is sufficiently wide near the equator to accommodate a 15000 km wave so that both phases of the wave are present at one time whereas the Atlantic has room only for half a wave. Below the thermocline the oceanic response corresponds to an equatorial Rossby wave with upward and westward phase propagation, and appears to be forced by variations of the vertical velocity at the base of the thermocline. On the interannual time scale, fluctuations of surface wind and sea surface temperature in association with the Southern Oscillation

are practically in place. Variations of the sea surface temperature are confined east of the dataline and those of wind are near or west of the dataline where they have strong latitudinal shear equatorward of 10 deg N and 10 deg S. The associated wind curl induces huge thermocline flucuations centered near 8 deg N and 8 deg S in the western Pacific. This meridional structure is different from that in the east where thermocline displacements are centered on the equator. An eastward phase propagation is found in the thermocline displacements near the equator. The phase speed is about 20 cm/s and it is associated with the superposition of waves (Kelvin and Rossby) plus motion directly forced by the wind. This slow eastward phase propagation provides the transition from El Nino to La Nina and vice versa. Dissert. Abstr.

N91-24709# Nevada Univ. System, Reno. Atmospheric Sciences Center.
INVESTIGATIONS OF WINTER MOUNTAIN STORMS IN UTAH DURING THE 1987 UTAH/NOAA FIELD PROGRAM Final Report
A. W. Huggins Jan. 1990 230 p Sponsored by Utah Div. of Water Resources, Salt Lake City
(PB91-140442) Avail: NTIS HC/MF A11 CSCL 04B

Results of investigations of winter storms which occurred in the vicinity of the Tushar Mountains in southern Utah during the 1987 Utah/NOAA field research program are presented. Emphasis was placed on the study of supercooled liquid water development and the delivery of seeding materials to clouds over the mountains. Dissert. Abstr.

N91-24710*# Wisconsin Univ., Madison. Space Science and Engineering Center.
COLLECTION AND ANALYSIS OF RADAR RAINFALL AND SATELLITE DATA FOR THE DARWIN TRMM EXPERIMENT Final Report, 1 Dec. 1990 - 31 May 1991
David W. Martin and Barry B. Hinton 15 Jun. 1991 24 p
(Grant NAG5-1308)
(NASA-CR-188237; NAS 1.26:188237) Avail: NTIS HC/MF A03 CSCL 04B

The following subject areas are covered: video cloud camera (purpose, design, operation, data); special observing periods (SOP-2, SOP 2.5 - an extension of SOP-2); Garand algorithm; and warm rain. Author

N91-24711# National Climatic Data Center, Asheville, NC.
JOINT US NAVY/US AIR FORCE CLIMATIC STUDY OF THE UPPER ATMOSPHERE. VOLUME 5: MAY Final Report
Michael J. Changery, Claude N. Williams, Michael L. Dickenson, and Brian L. Wallace Sep. 1989 235 p
(AD-A232977; NAVAIR-50-1C-5; AWS-XN-TR-89/005) Avail: NTIS HC/MF A11 CSCL 04/2

This joint Navy and Air Force study of the upper atmosphere is based on 1980 to 1985 twice daily gridded analysis produced by the European Centre for Medium Range Weather Forecasts. Included are global analyses by (1) Mean atmospheric temperature/standard deviation, (2) Mean geopotential height/standard deviation, (3) Mean atmospheric density/standard deviation, (4) Height and vector standard deviation (All data are for 13 pressure levels - 1000, 850, 700, 500, 400, 300, 250, 200, 150, 100, 70, 50, and 30 mb), (5) Mean dew points/standard deviation - levels 1000 through 300 mb, and (6) Jet streams (mean scalar speed) - levels 500 through 30 mb. Also included are global 5 deg grid point wind roses for the 13 pressure levels. GRA

N91-24712# Air Force Environmental Technical Applications Center, Scott AFB, IL.
TEMPERATURE CLIMATOLOGY FOR 128 NAVY INSTALLATIONS IN THE CONUS AND HAWAII
Debra L. Runyon Dec. 1990 63 p
(AD-A232993; USAFETAC/PR-90/002) Avail: NTIS HC/MF A04 CSCL 04/2

This report provides tabular temperature climatology for 128 Navy installations in the CONUS, Guam, Hawaii, and Puerto Rico. Data was prepared for the Naval Energy and Environmental Support Activity for inclusion in a study of the feasibility if using coal as a primary source for heat fuels. Tables give the following for each location: Annual heating degree days, 99 and 97.5 percent winter design temperatures, mean annual temperature. Also given: Monthly heating degree days, mean temperatures, record low temperatures. All temperatures are in degrees fahrenheit. GRA

N91-24713# Air Force Environmental Technical Applications Center, Scott AFB, IL.
SURFACE OBSERVATION CLIMATIC SUMMARIES FOR REESE AFB, TEXAS Data Report, Mar. 1942 - Aug. 1989
Mar. 1990 375 p
(AD-A233008; USAFETAC/DS-90/205) Avail: NTIS HC/MF A16 CSCL 04/2

Surface observation climatic summaries (SOCS) provide statistical summaries of surface weather observations taken and recorded at specified observing stations. Hourly observations are summarized from a 10-year periods of record. Data include: meteorological phenomena, weather, ceiling, cloud cover, snow depth, humidity, barometric pressure, atmospheric precipitation, atmospheric temperature, visibility, and surface wind. GRA

N91-24714# Air Force Environmental Technical Applications Center, Scott AFB, IL.
HIRAS USAFETAC CLIMATIC DATABASE USERS HANDBOOK NUMBER 5, REVISION
Feb. 1991 12 p
(AD-A233023; USAFETAC/UH-88/001-Rev) Avail: NTIS HC/MF A03 CSCL 12/7

This handbook provides users of the high Resolution Analysis System (HIRAS) climatic database with information on its history, production, and content. It also discusses processing and quality control procedures, describes database format, and tells users how to obtain HIRAS climatic data. The Air Force Global Weather Central (AFGWC) at Offutt AFB, Nebraska, began operational production of the HIRAS upper-air analysis in August 1984. Operational production of AFGWC's upgraded Advanced Weather Analysis and Prediction System (AWAPS) HIRAS began in October 1985. USAFETAC's Operating Location A at Asheville, North Carolina, began building the HIRAS climatic database starting with January 1985 data. HIRAS is the primary upper-air analysis system used in AWAPS. It produces global upper-air analysis data every 6 hours. AFGWC sends that data to OL-A twice a day for inclusion in the HIRAS Climatic Database. GRA

N91-24715# ST Systems Corp., Lexington, MA.
WEATHER RADAR TECHNOLOGY DEVELOPMENT Final Report, 16 May 1987 - 15 May 1990
F. I. Harris, Ralph J. Donaldson, Jr., Paul Desrochers, Donald Hamann, and Teresa Bals 15 Aug. 1990 102 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Contract F19628-87-C-0124)
(AD-A233071; GL-TR-90-0201) Avail: NTIS HC/MF A06 CSCL 04/2

Techniques have been developed to automatically analyze Doppler weather radar data to detect, assess, and predict weather that adversely affects Air Force operations. Focus has been on severe wind events associated with tornadic storms and hurricanes, wind shear events, large hail, and tracking of precipitation. The energetics of mesocyclones within severe storms have been estimated and used to improve the probability of detection and reduce the false alarm ratio for tornadoes and to discriminate storms producing violent, strong, or weak tornadoes. This rotational intensity and the divergence provide very good guidance in determining the potential of large hail production. Of several tested parameters, potential-vortex fit has been found to accurately discriminate the behavior of hurricanes. This parameter is relatively insensitive to storm location. A new technique for gradient detection has been developed to detect synoptic scale fronts and gust fronts. It is also used with a contour extraction routine based on the Freeman Chain code to monitor and track precipitation regions. These techniques require further research. An efficient and effective

two-dimensional velocity dealiasing technique has been developed that successfully treats more than 99 percent of the data. GRA

N91-24716# Air Force Environmental Technical Applications Center, Scott AFB, IL.
MISAWA SNOW ACCUMULATION STUDY
William R. Schaub, Jr. Feb. 1991 26 p
(AD-A233113; USAFETAC/PR-91/001) Avail: NTIS HC/MF A03 CSCL 04/2

The development is described of statistically significant thresholds of 11 atmospheric variables for forecasting snow at Misawa Air Base, Japan. The 11 variables were: gradient level temperature and dew point atmospheric temperature, 850-mb temperature, 700-mb temperature, thickness for five layers between 1,000 feet AGL and 500 mb, gradient wind direction, and gradient wind velocity. USAFETAC did simple correlations of each variable with observed 6 hour snowfall amounts to develop a linear regression equation that would predict 6 hourly snowfall amounts. Since the linear regression did not show skill, the study was expanded to develop a decision tree for making a yes or no snow determination. The USAFETAC developed decision tree scored well using dependent data, but not very well on independent data; it lost to persistence. USAFETAC does not recommend either technique for use in operational forecasting, but suggests further development and evaluation of the decision tree over a longer period of record. GRA

N91-24717# Lawrence Livermore National Lab., CA.
TEN KEY QUESTIONS INDICATING THE LEVEL OF CURRENT UNCERTAINTY IN FORECASTING CLIMATIC CHANGE
M. C. MacCracken Feb. 1991 16 p
(Contract W-7405-eng-48)
(DE91-010124; UCRL-ID-106243) Avail: NTIS HC/MF A03

Predicting the consequences of the increasing atmospheric concentrations of carbon dioxide (CO2), methane (CH4), chlorofluorocarbons (CFCs), and other trace gases (collectively, greenhouse gases) poses a three part research challenge: (1) to determine future changes in atmospheric composition; (2) to determine the consequent changes to the climate system; and (3) to determine the impacts (both detrimental and beneficial) that these changes could induce on the biosphere and natural and societal resources. Areas of agreement related to the first two of these challenges are described and responses are then offered to ten questions to indicate the degree of uncertainty and research challenges remaining. DOE

N91-24718# Massachusetts Univ., Amherst.
A COMPREHENSIVE PRECIPITATION DATA SET FOR GLOBAL LAND AREAS
J. K. Eischeid, H. F. Diaz (Colorado Univ., Boulder.), and R. S. Bradley Apr. 1991 87 p
(Contract DE-FG02-89ER-69017)
(DE91-010321; DOE/ER-69017/T-H1) Avail: NTIS HC/MF A05

An expanded and updated compilation of long term station precipitation data, together with a new set of gridded monthly mean fields for global land areas are described. The present data set contains 5328 station records of monthly total precipitation, covering the period from the mid-1800s to the late 1980s. The station data were individually tested and visually inspected for the presence of spurious trends, jumps and other measurement biases. The quality control procedure which was used to check the station records for non-climatic discontinuities and other biases is detailed. The authors also discuss some of the problems which typically contribute to potential inhomogeneities in precipitation records. The station data were interpolated onto a 4 deg latitude by 5 deg longitude uniform grid. Comparisons of these data with two other global scale precipitation climatologies are presented. They find good agreement among the three global scale climatologies over the common areas in each set. Three different indices of long term precipitation variations over the global land areas all indicate a general increase of annual precipitation since the 1940s, although a decline is evident over the last decade. There is some indication that the last few decades of the 19th century may have been as wet as the recent ones. An interesting feature is the presence of relatively large differences in seasonal trends, with March-May and September-November becoming wetter in the last few decades. The December-February and June-August seasons exhibit smaller overall trends, although the northern winter season does exhibit large decadal-scale fluctuations. DOE

N91-24719*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ATLAS OF WIDE-FIELD-OF-VIEW OUTGOING LONGWAVE RADIATION DERIVED FROM NIMBUS 7 EARTH RADIATION BUDGET DATA SET, NOVEMBER 1985 TO OCTOBER 1987
T. Dale Bess and G. Louis Smith Washington Jun. 1991 53 p
(NASA-RP-1261; L-16934; NAS 1.61:1261) Avail: NTIS HC/MF A04 CSCL 04B

An atlas of monthly outgoing longwave radiation global contour maps and associated spherical harmonic coefficients is presented. The atlas contains 23 months of data from November 1985 to October 1987 . The data were derived from the second Earth Radiation Budget (ERB) package, which was flown on the Nimbus 7 Sun-synchronous satellite in 1987. This data set is a companion set and extension to similar atlases that documented 10 years of outgoing longwave radiation results from Nimbus 6 and Nimbus 7 satellites. This atlas and the companion atlases give a data set covering a 12-year time period and will be very useful in studying different aspects of our changing climate. The data set also provides a 3-year overlap with the current Earth Radiation Budget Experiment (ERBE). Author

N91-24720*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ATLAS OF THE EARTH'S RADIATION BUDGET AS MEASURED BY NIMBUS-7: MAY 1979 TO MAY 1980
H. Lee Kyle, Richard R. Hucek, and Brenda J. Vallette (Research and Data Systems, Inc., Greenbelt, MD.) Washington May 1991 137 p
(Contract NAS5-29373)
(NASA-RP-1263; NAS 1.61:1263; Rept-91B00081) Avail: NTIS HC/MF A07 CSCL 04B

This atlas describes the seasonal changes in the Earth's radiation budget for the 13-month period, May 1979 to May 1980. It helps to illustrate the strong feedback mechanisms by which the Earth's climate interacts with the top-of-the-atmosphere insolation to modify the energy that various regions absorb from the Sun. Cloud type and cloud amount, which are linked to the surface temperature and the regional climate, are key elements in this interaction. Annual, seasonal, and monthly maps of the albedo, outgoing longwave and net radiation, noontime cloud cover, and mean diurnal surface temperatures are presented. Annual and seasonal net cloud forcing maps are also given. All of the quantities were derived from Nimbus-7 satellite measurements except for the temperatures, which were used in the cloud detection algorithm and came originally from the Air Force 3-dimensional nephanalysis dataset. The seasonal changes are described. The interaction of clouds and the radiation budget is briefly discussed. Author

N91-24170*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATED DATA ANALYSIS OF JULY 7, 1990 MICROBURST
Dave Hinton *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 63-79 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 04B

N91-24171*# Mesoscale Environmental Simulations and Operations, Inc., Hampton, VA.
MODEL COMPARISON OF JULY 7, 1990 MICROBURST
Fred Proctor *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined

Manufacturers' and Technologists' Conference, Part 1 Jan. 1991 p 81-103 (For primary document see N91-24166 16-03)
Avail: NTIS HC/MF A21 CSCL 04B

N91-24664# Meteorological Satellite Center, Tokyo (Japan).
A USAGE OF WIND DATA DERIVED FROM GMS IN THE UPPER TROPICS
Kazumasa Tada *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 25-32 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

N91-24666# Meteorological Satellite Center, Tokyo (Japan).
AN ESTIMATION OF SURFACE WIND PROFILE WITHIN THE RANGE OF 200 km FROM A TYPHOON CENTER USING GMS IMAGES
Koetsu Chubachi *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 47-55 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

N91-24667# Meteorological Satellite Center, Tokyo (Japan).
THE REPRESENTATION OF Cb CLUSTER'S LIFE CYCLE USING TBB DATA AND RADAR DATA
Masami Sakurada *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 57-72 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

N91-24721 Royal Netherlands Meteorological Inst., De Bilt. Div. of Oceanographic Research.
A PRIMARY EXPERIMENT OF STATISTICAL INTERPOLATION SCHEME USED IN SEA WAVES DATA ASSIMILATION
Quanduo Gao (National Research Center for Marine Environment Forecasting, Beijing, China) 4 Sep. 1990 26 p
(KNMI-TR-128; ISSN-0169-1708; ETN-91-99104) Copyright
Avail: Royal Netherlands Meteorological Inst., P.O. Box 201, 3730 AE DeBilt, Wilhelminalaan 10, Netherlands

A statistical interpolation method which may incorporate the spatial information of forecast error of sea waves by analytical correlation functions is described. The basic assumptions are that the correlation of observed data is random and the cross correlation of observation between wind and waves is independent. Based on observed data, the analysis shows that there exists the same statistical property for both hindcast error and forecast error. The least square technique is used to fit isotropical and anisotropical functions, which may be used for sea wave data assimilation. The Fourier transform of correlation function, or wave number spectrum, is used to indicate the contribution of correlation to the interpolation and to determine the truncation length of the correlation. ESA

N91-24722# National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
OCEAN SURFACE CURRENT MEASUREMENTS WITH A SINGLE-STATION, DOPPLER/SPACED-ANTENNA RADAR
B. L. Weber, D. B. Wuertz, P. T. May, R. G. Strauch, and D. A. Merritt Nov. 1990 24 p
(PB91-142307; NOAA-TM-ERL-WPL-190) Avail: NTIS HC/MF A03 CSCL 08C

The authors conducted a preliminary experiment to determine the feasibility of using one radar to measure the two-dimensional ocean surface current. The Doppler method was used to measure the radial component and the Spaced Antenna method was used to measure the transverse component of the current. This dual method produced current measurements that showed consistency over range and time, demonstrating potential for the technique. However, the experiment also raises some questions. On occasions, the SA method seemed to be very sensitive to noise, producing apparently erroneous results. Therefore, the authors have planned a more definite experiment with improved radar antennas, improved data acquisition, and independent current observations for comparisons. Dissert. Abstr.

N91-24723# California Univ., San Diego, La Jolla.
ARRAY MEASUREMENTS OF SURFACE GRAVITY WAVES Ph.D. Thesis
Thomas H. Herbers 1990 126 p Sponsored by ONR and NOAA
(AD-A233318) Avail: NTIS HC/MF A07 CSCL 08/3

Local properties of natural, wind generated, surface gravity waves are examined with arrays of pressure transducers. Two methods are presented for interpretation of array measurements. First, an estimator for wave radiation stresses and energy fluxes is derived, applicable to an array of 4 pressure transducers arranged in a square. The technique is based on an expansion for small kL with k the wave number and L the sensor separation. A variational method for estimating directional wave spectra, applicable to arbitrary array geometries in constant or slowly varying depth water is presented next. A smooth estimate of the directional distribution of wave energy S (Theta) is obtained by minimizing a roughness measure. Model tests show that spurious features are effectively rejected by the smoothness constraint, and illustrate the importance of data-independent information. Estimates of S(Theta), obtained from field data collected offshore of a mildly sloping beach, show that reflection of incident sea and swell is very weak. Observations of sea floor pressure fluctuations in 13 m depth are compared to a theory for weakly nonlinear surface gravity waves. Nonlinear interactions between directionally opposing seas theoretically excite long wavelength, double sea frequency forced waves that are only weakly attenuated at the sea floor. Observed bottom pressure spectra show that large fluctuations in double sea frequency (0.35 to 0.6 Hz) forced wave energy can occur in only a few hours. GRA

51 LIFE SCIENCES (GENERAL)

N91-24724# American Red Cross, Rockville, MD.
INTERNATIONAL CONFERENCE ON BIOPHYSICS OF TRANSMEMBRANE ELECTRIC FIELDS Report, 1 Jan. - 31 Dec. 1990
Arthur E. Sowers 15 Nov. 1990 77 p Conference held in Elkridge, MD, 23-26 Oct. 1990
(Contract N00014-90-J-1562)
(AD-A232057) Avail: NTIS HC/MF A05 CSCL 09/1

It is commonly accepted that efficiency of cell electrofusion is higher when cells are preliminary brought in closer contact. On this base two new approaches in cell electro fusion have been developed. The first one, fusion of cells on an electroconductive (cellulose) film, is very effective for spreading cells (e.g., mouse L-cells) that are able to attach to solid surfaces. The second, more universal, approach is electrofusion of cells in centrifugated pellets. Specific features of cell contacts and possible mechanism of electrofusion are discussed. Electric fields are supposed to initiate fusion process only in areas where plasma membranes of contacting cells are divided narrow extended gaps. GRA

N91-24725# Wake Forest Univ., Winston-Salem, NC. School of Medicine.
MULTIPLE NEURON RECORDING IN THE HIPPOCAMPUS OF FREELY MOVING ANIMALS Annual Progress Report, 1 Dec. 1989 - 30 Nov. 1990
Samuel A. Deadwyler 27 Dec. 1990 6 p

(Grant AF-AFOSR-0092-90; AF Proj. 3484)
(AD-A232934; AFOSR-91-0112TR) Avail: NTIS HC/MF A02 CSCL 06/4

Progress over the last year on the development of multineuronal recording systems has been significant. Since this was one of the main objectives of the consortium of three laboratories it has been a principle focus of the past years research efforts. This phase is near completion and currently being implemented in several research projects. Consequently most of the research effort in the past year has been directed toward these technological accomplishments. However in addition to the strides made in bringing the multineurone and multi-tasking computer systems to completion, several studies which were in preliminary stages at the time of submission are now near completion, several studies which were in preliminary stages at the time of submission are now near completion and are being prepared for publication. Specifically, these include the signal detection task and the DMTS task in which complex neurophysiological analyses have revealed striking new relationships to sensory processing strategies in the hippocampus and cortex. The accompanying report summarizes these and other accomplishments in the first year of the award. GRA

N91-24726# Colorado Univ., Denver. Center for Environmental Sciences.
EXPLORATORY DATA ANALYSIS ON DATA GENERATED IN THE DOE SUBSURFACE MICROBIOLOGY PROGRAM
R. R. Meglen Jun. 1990 96 p
(Contract DE-FG02-87ER-60557)
(DE91-007575; DOE/ER-60557/1) Avail: NTIS HC/MF A05

The preliminary results from the innovative subsurface microbiology research program indicate that new data on the nature of the link between the geosphere and biosphere have been generated. The diversity of scientific disciplines represented in the subsurface microbiology program reflects the complexity of the system under study. The research carried out by national laboratory and university research scientists is addressing fundamental questions about the abundance of microorganisms and factors controlling microbial activity in the complex subsurface hydrologic and geochemical environment. Long-term implications of this research for mitigating contamination are clear and researchers share the broader objective of linking the basic science with applied work. DOE

N91-24727# Pacific Northwest Lab., Richland, WA.
BIOLOGICAL EFFECTS OF ELECTROMAGNETIC FIELDS
L. E. Anderson Mar. 1991 6 p Presented at the International Zurich Symposium and Technical Exhibition on Electromagnetic Compatibility, Zurich (Switzerland), 12-14 Mar. 1991
(Contract DE-AC06-76RL-01830)
(DE91-010006; PNL-SA-18947; CONF-9103152-1) Avail: NTIS HC/MF A02

Natural background levels of atmospheric electric and geomagnetic field levels are extremely low. Over the past several decades, however, human beings and other life forms on this planet have been subjected to a dramatically changing electromagnetic milieu. Exponential increases in exposure to EM fields have occurred, largely because of technological advances associated with increased use of electricity; e.g., expanding power generation and transmission systems, the increased use of wireless communications, and radar. EM field generating devices have proliferated in industrial plants, office buildings, homes, public transportation systems, and elsewhere. Significant increases have occurred in EM field strengths spanning all frequency ranges; therefore, a brief overview is presented of the potential impacts of these fields, primarily at extremely low frequencies (ELF), but also at MW and RF. DOE

N91-25094*# Park (George W.) Seed Co., Inc., Greenwood, SC.
SEEDS IN SPACE EXPERIMENT RESULTS Abstract Only
Jim A. Alston *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 129 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 06C

N91-25095*# Oklahoma State Univ., Stillwater.
SPACE EXPOSED EXPERIMENT DEVELOPED FOR STUDENTS (SEEDS) P-0004-2 Abstract Only
Doris K. Grigsby *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 130 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 06C

N91-25096*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Biophysics Div.
FIRST BIOLOGICAL AND DOSIMETRIC RESULTS OF THE FREE FLYER BIOSTACK EXPERIMENT AO015 ON LDEF Abstract Only
G. Reitz, H. Buecker, R. Facius, G. Horneck, M. Schaeffer, J. U. Schott, J. Bayonove, R. Beaujean, E. V. Benton, and M. Delpoux (Toulouse Univ., France) et al *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 131 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 06C

52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

N91-24728 Tel-Aviv Univ. (Israel). Dept. of Bio-Medical Engineering.
INTERACTION BETWEEN LASER BEAM AND BIOLOGICAL TISSUE: A COMPARISON BETWEEN CO2, Nd:YAG AND Ho:YAG LASERS M.S. Thesis
Ricardo Schleifer Sep. 1988 77 p In HEBREW; ENGLISH summary
(ITN-90-85022) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel, pricing information obtainable from document source

CO2 and Nd:YAG lasers are widely applied in surgery. The 10.6 micron wavelength radiation from the CO2 laser is highly absorbed in water, which is the main component of biological tissue. Vaporization and cutting are the main applications of this laser. The 1.06 micron radiation from the Nd:YAG laser is negligibly absorbed by water, hence its main use is in tissue coagulation. This radiation can be transferred through optical fibers and is widely used in endoscopic applications. The 2.1 micron radiation from the holmium laser is more absorbed in water than that from the Nd:YAG laser but less than that from the CO2 laser. This radiation can be transferred through optical fibers and the laser can be operated in continuous wave or pulsed wave modes. The tissue interaction of the above laser radiations was studied, especially that of the holmium lasers, which are under development. The assumptions are that the holmium laser will coagulate less and vaporize more than the Nd:YAG laser and will coagulate more and vaporize less than the CO2 laser. It was also assumed that less thermal damage will be caused to the tissue by the pulsed holmium laser than by the continuous wave holmium laser, when the beam energy is the same. In order to prove the above assumptions, about 250 experiments were performed on different kinds of tissue such as liver, kidney, pancreas and spleen. The experiments were carried out on dogs using the above four lasers with the same power and exposure time. Data on the different thermal damage zones were collected by analyzing the various histological sections. The results indicate that the holmium laser coagulates more than the CO2 laser and vaporizes less than the Nd:YAG laser. More damage is caused to the tissue by the continuous wave holmium laser than by the pulsed holmium laser, when the same energy densities are applied. It was also shown that when the beam energy is fixed, the tissue thermal damage is directly proportional to the exposure time, i.e., inversely proportional to the power. ISA

N91-24729# Army Biomedical Research and Development Lab., Fort Detrick, MD.
EXPOSURE STANDARD FOR FOG OIL Technical Report, Dec. 1989 - Nov. 1990
Winifred G. Palmer 15 Nov. 1990 45 p
(AD-A231714; USABRDL-TR-9010) Avail: NTIS HC/MF A03 CSCL 06/7

Effects of mineral oils in animals and humans are evaluated and serve as the basis for the development of an exposure standard for fog oil. Considered are health hazards associated with fog oil purchased before and after the Military Specification was amended in April 1986 to exclude carcinogens. While repeated exposure to conventionally-refined mineral oils may cause pulmonary disease as well as severe dermatoses and cancer of the skin and scrotum, lipoid pneumonia is the major health hazard associated with highly refined mineral oils such as fog oils purchased after April 1986. While the course of lipoid pneumonia can be asymptomatic in some individuals, in others its symptoms can range from occasional cough to severe, debilitating dyspnea and pulmonary illness, occasionally ending in death. GRA

N91-24730# Office of Technology Assessment, Washington, DC.
IDENTIFYING AND CONTROLLING IMMUNOTOXIC SUBSTANCES: BACKGROUND PAPER
1991 96 p
(OTA-BP-BA-75) Avail: NTIS HC/MF A05; also available SOD HC $4.50 as 052-003-01231-6

The following subject areas are covered: the immune system and immunotoxicity; immunotoxicological tests; and Federal attention to immunotoxicants. Author

N91-24731* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 349)
May 1991 50 p
(NASA-SP-7011(349); NAS 1.21:7011(349)) Avail: NTIS HC A03; NTIS standing order as PB91-912300, $15.00 domestic, $30.00 foreign CSCL 06E

This bibliography lists 149 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during April, 1991. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

N91-24732# School of Aerospace Medicine, Brooks AFB, TX.
AN EVALUATION OF THE PHOTOPIC ELECTRORETINOGRAM USING LOWER EYELID ELECTRODES Interim Report, Jan. 1988 - Jan. 1990
Linda B. Anderson and J. T. Yates Dec. 1990 15 p
(AD-A232988; USAFSAM-TP-90-23) Avail: NTIS HC/MF A03 CSCL 20/6

The use of corneal contact lens electrodes for recording Electroretinograms (ERG) is difficult in some patients (children) and impossible in others (hyperbaric patients) due to unusual recording conditions. After reviewing the various published methods already tested, a technique was used that employs a lower eyelid electrode. In addition, a Ping-Pong ball Ganzfeld was fabricated to mimic the Ganzfeld dome typically used in clinical laboratories. Three questions were then addressed: (1) the adequacy of the method for acquiring photopic ERGs; (2) the influence of the direction of gaze on ERG parameters; (3) the day-to-day reliability of the method. When ERGs derived from contact lens electrodes were compared with those obtained from lower eyelid electrodes under the same test conditions, it was found that the lower eyelid electrode waveforms were smaller in amplitude but identical in shape to wave forms produced by corneal contact lens electrodes. GRA

N91-24733# Pittsburgh Univ., PA. Dept. of Psychiatry.
ORGANIZATION OF THE HUMAN CIRCADIAN SYSTEM Final Report, 1 Dec. 1989 - 30 Nov. 1990
Robert Y. Moore 24 Jan. 1991 7 p
(Grant AF-AFOSR-0097-90; AF Proj. 2312)
(AD-A233026; AFOSR-91-0190TR) Avail: NTIS HC/MF A02 CSCL 06/5

Significant progress has been made in analyzing the anatomical makeup of the human suprachiasmatic nucleus (SCN) and adjacent structures. The largest population of neurons in the human SCN are neurotensin containing neurons. The human SCN also contains vasopressin, vasoactive intestinal polypeptide and neuropeptide y. Development of DiI methods to study connections between neuronal populations has been disappointing and new approaches are now being explored. GRA

N91-24734# Central Inst. for the Deaf, Saint Louis, MO.
AUDITORY-ACOUSTIC BASIS OF CONSONANT PERCEPTION. ATTACHMENTS A THRU I Final Technical Report, 30 Sep. 1986 - 31 Dec. 1989
James D. Miller 22 Jan. 1991 855 p
(Grant AF-AFOSR-0335-86; AF Proj. 2313)
(AD-A233041; AFOSR-91-0130TR) Avail: NTIS HC/MF A99 CSCL 05/7

New facts of this auditory-acoustic basis perception were discovered as listed. (1) Plosive consonants can be distinguished from fricative consonants by the peak rate of rise intensity at their onsets. (2) The acoustic characteristics that serve to identify plosive bursts and voiceless fricatives by place of articulation can be usefully described in terms of format defined by a novel algorithm. (3) A connectionist software model that examines fourteen psychophysically relevent acoustic measures can classify any acoustic segment of speech by the location of its source in the talker's vocal tract. (4) Preliminary studies of sonorant and nasal consonants have identified the putative acoustic cues for their identification by human listeners and/or machines. (5) New methods for format tracking were developed. (6) An important set of software tools were developed that allow further studies of the auditory acoustic basis of consonant perception. (7) These tools have also aided in the studies of vowels and diphthongs, whose characteristics are being elucidated under primary support from the National Institutes of Health. GRA

N91-24735# School of Aerospace Medicine, Brooks AFB, TX.
CHOROIDAL NEVI IN USAF AVIATORS Interim Report, Jun. 1988 - Jun. 1989
Daniel L. Vandivort, Thomas J. Tredici, and Robert P. Green, Jr. Dec. 1990 6 p
(AD-A233042; USAFSAM-TP-89-11) Avail: NTIS HC/MF A02 CSCL 06/5

A choroidal nevus may be mistaken for a melanoma or it may develop into a malignant melanoma. We reviewed the records of over 5,000 aviators examined over the past 14 years at the USAF School of Aerospace Medicine. One hundred and fourteen aviators were noted to have one or more choroidal nevi (2.2 percent). These lesions were found not to affect the aviators' visual performance. However, it is recommended that these lesions be followed at regular intervals by an ophthalmologist. GRA

53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

N91-24736# Naval Aerospace Medical Research Lab., Pensacola, FL.
MODELING FOR HUMAN PERFORMANCE ASSESSMENT Annual Report, 15 Nov. 1989 - 15 Nov. 1990
R. R. Stanny 20 Nov. 1990 16 p
(DA Proj. 3M2-63002-D-995)
(AD-A232905) Avail: NTIS HC/MF A03 CSCL 05/8

This Annual Report describes two lines of research performed during Fiscal Year 1990 at the Naval Aerospace Medical Research Laboratory. One research line involved developing a generic model of human performance tests, such as those in the United Triservice Cognitive Assessment Battery and the Walter Reed Army Institute of Research Performance Assessment Battery. Several performance-test models were developed using the plan of the generic task. The generic model might serve both as a vehicle for quantifying laboratory performance and a blueprint for analyses of operational systems. A second research line focused on a risk identification study of 31 Navy and Marine aircraft carrier combat occupations. The data were from task analyses performed by Cooper, Schemmer, Fleishman, Yarkin-Levin, Harding, and McNelis (1987). The purpose was to examine whether knowledge of a stressor's effects on abilities might be used to predict those combat jobs most affected by the stressor. Notable among the abilities exhibiting substantial variation in importance across jobs (a necessary property for predicting differential stressor effects) were far vision, spatial orientation, flexibility of closure, and rate control. Examining the effects of stressors on these and related abilities may yield information of value in predicting the threats posed by stressors to different members of this set of occupations. GRA

N91-24737# Northwestern Univ., Evanston, IL.
MECHANISMS OF MOTION PERCEPTION: INTEGRATION OF DIRECTION, VELOCITY, AND SPACE Final Report, 1 Jan. 1989 - 30 Jun. 1990
Robert Sekuler 10 Feb. 1991 211 p Prepared in cooperation with Brandeis Univ., Waltham, MA
(Grant AF-AFOSR-0243-89; AF Proj. 2313)
(AD-A233340; AFOSR-91-0189TR) Avail: NTIS HC/MF A10 CSCL 06/4

Statistically complex displays were used to probe higher order mechanisms of human motion perception. Overall, the project sought to characterize human visual mechanisms that extract information from these and other displays. A fundamental contribution of the project has been the continued refinement of mathematical models in which motion information is extracted and processed, via non-linear interactions, by an ensemble of directionally-selective visual mechanisms. Additionally, one entirely new line of research examines the formation of the visual system's abstract representation of information about change in target direction. GRA

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

N91-24738# Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
A MOTION ACTIVATED ARTICULATING SEAT (MAAS): A DYNAMIC CONCEPT FOR COCKPIT SEAT DESIGN IN HIGH PERFORMANCE AIRCRAFT Special Report, Aug. 1987 - Aug. 1988
Vance D. Skowronski, Robert Esken, James Cooper, and Alva Karl Nov. 1990 5 p Prepared in cooperation with Systems Research Labs., Inc., Dayton, OH
(AD-A231698; AAMRL-SR-90-508) Avail: NTIS HC/MF A01 CSCL 01/3

The motion activated articulating seat (MAAS) is a pilot aid in lifting the shoulder/upper torso while flying an aircraft. The MAAS system has the ability to respond rapidly should the pilot require a different shoulder/upper torso position in response to changing mission requirements, such as checking 6. The approach uses a high speed desk top computer, a video camera, a specialized video processing capture board, a set of specifically geometrically designed air bags (three independently functionable) with operational valving, a modified cockpit seat with a 30 degree seat back angle, a flight helmet with identifiable indicators, and an in house developed operating software program. The system has been demonstrated statistically and successfully processed head/helmet movements for generating seat motion. The video capture technique is being applied to other laboratory research efforts. GRA

N91-24739# Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA.
FORMULATIVE EVALUATION STUDY OF A PROTOTYPE NEAR-INFRARED PROJECTION SYSTEM: NIGHT VISION GOGGLE STUDY Interim Report, Aug. - Dec. 1988
Gena M. Pedroni and Gabriel P. Intano Jan. 1991 38 p
(AD-A231759; ARI-RN-91-15) Avail: NTIS HC/MF A03 CSCL 23/2

U.S. Army Aviation relies upon image intensifiers, such as night vision goggles (NVGs), for night nap-of-the-earth (NOE) flight. During initial flight training, OH-58 student pilots are expected to apply academic knowledge of NVG use in flight after limited review. To facilitate OH-58 students' transition to NVG flight, researchers projected images through a prototype near-infrared (IR) video projection system. Helicopter pilot students received hands-on experience with the AN/PVS-5A NVGs, which are compatible with the projection system's output range. Instructor pilots rated OH-58 students' flight performance throughout the night/NVG phase of instruction. A strong positive effect on students' confidence (increase) and anxiety (decrease) levels were observed. No difference in flight performance was observed between matched pairs (experimental vs. control) of students. Additional research is planned in the areas of safety of flight, terrain navigation, special operations, mission planning, and threat recognition. GRA

N91-24740# Department of Transportation, Cambridge, MA.
SHIPBOARD CREW FATIGUE, SAFETY AND REDUCED MANNING Final Report, Jan. 1989 - Nov. 1990
J. K. Pollard, E. D. Sussman, and M. Stearns Nov. 1990 109 p Sponsored by Maritime Administration, Washington
(PB91-138099; DOT-VNTSC-MARAD-90-1;
DOT-MA-RD-840-90014) Avail: NTIS HC/MF A06 CSCL 06/16

An exploratory first phase of an investigation of human stress and fatigue in the merchant marine is described. Its principle purposes were to survey the effects of fatigue on human performance in the transportation industries, describe the state of the art in measuring fatigue, investigate the causes of stress and fatigue on merchant ships, summarize the insights gained about the implications of reduced manning as well as measures to mitigate fatigue, and discuss the results of preliminary attempts to gauge fatigue during the routing voyages using survey methods. It was concluded that organization and design factors could provide opportunities under some circumstances for the design and operation of advanced merchant ships which can be sailed safely and efficiently by well-rested crews which are smaller than are common today. Dissert. Abstr.

N91-24741# California Univ., Los Angeles.
BENCHMARKING TEXT UNDERSTANDING SYSTEMS TO HUMAN PERFORMANCE: AN EXPLORATION Project Report No. 6, 1 Sep. 1989 - 30 Sep. 1990
Frances A. Butler, Eva L. Baker, Tine Falk, Howard Herl, and Younghee Jang Sep. 1990 69 p
(Contract N00014-86-K-0395; NR Proj. RR0-4206)
(AD-A233306) Avail: NTIS HC/MF A04 CSCL 05/7

This report explores the use of natural language in intelligent computer systems specifically with regard to text understanding systems. The goal of the research was to benchmark selected text understanding systems to human performance in reading comprehension. To this end a reading comprehension test was compiled which included the texts and questions from six intelligent computer systems. This test along with a criterion reading measure was administered to the subjects in the study. The computer systems' performances were then benchmarked to a scale of

human performance on reading comprehension as part of the development of the Artificial Intelligence Measurement System (AIMS). GRA

N91-24742# California Univ., Los Angeles. Center for the Study of Evaluation.
HUMAN BENCHMARKING OF EXPERT SYSTEMS Interim Project Report No. 20, 1 Jul. 1989 - 30 Jan. 1990
Harold F. ONeil, Jr., Yujing Ni, Anat Jacoby, and Kathleen M. Swigger Sep. 1990 33 p
(Contract N00014-86-K-0395)
(AD-A233601) Avail: NTIS HC/MF A03 CSCL 12/5

This document outlines the strategy used for benchmarking expert systems to human performance. Two major alternatives for human benchmarking of expert system are proposed: computer science driven or psychological process driven. The computer science driven approach is either (1) expert system driven in which one picks an expert system which encodes an expert, derives psychological processes, and tests the processes with people, or (2) expert system shell driven in which one estimates the intelligence of the shell (parent), assumes that applied expert systems will have similar intelligence, then follows the procedures of the expert system driven approach. The psychological process driven approach involves picking a psychological process, finding an expert system that exemplifies the process, and then tailoring a test for the expert system and for people. The computer science driven approach was used to develop the expert system benchmarking methodology by relating cognitive taxonomies and expert system taxonomies. GRA

N91-24743# California Univ., Los Angeles.
HUMAN BENCHMARKING OF EXPERT SYSTEMS. LITERATURE REVIEW Interim Project Report, No. 19, 1 Jul. 1989 - 30 Jan. 1990
Harold F. ONeil, Jr., Yujing Ni, and Anat Jacoby Jan. 1990 48 p
(Contract N00014-86-K-0395)
(AD-A233602) Avail: NTIS HC/MF A03 CSCL 05/8

This literature review provides a context for using the human benchmarking approach with expert systems. It includes three parts: the current status of expert system evaluation; a search for cognitive instruments; and a parallel comparison of categories between expert systems and cognitive skill instruments. The review suggests that there are different approaches to expert system evaluation including evaluation criteria and evaluation procedures. The literature offers diverse environments for capturing developmental aspects of expert system evaluation. The review suggests the possibility of developing a psychometric standard for the evaluation of expert systems and documents similarities and differences between cognitive psychology and artificial intelligence, which is important for the human benchmarking approach. GRA

N91-24744*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEMS: NATURAL AND ARTIFICIAL ECOSYSTEMS
Robert D. MacElroy, ed., Brad G. Thompson, ed., Theodore W. Tibbitts, ed., and Tyler Volk, ed. (New York Univ., New York.) Dec. 1989 185 p The 27th COSPAR Meeting was held in Espoo, Finland, 18-29 Jul. 1988; sponsored by Subcommission F.4
(NASA-CP-10040; A-89105; NAS 1.55:10040) Avail: NTIS HC/MF A09 CSCL 06K

The scientists supported by the NASA sponsored Controlled Ecological Life Support Systems (CELSS) program have played a major role in creating a Committee on Space Research (COSPAR) section devoted to the development of bioregenerative life support for use in space. The series of 22 papers were sponsored by Subcommission F.4. The papers deal with many of the diverse aspects of life support, and with outgrowth technologies that may have commercial applications in fields such as biotechnology and bioengineering. Papers from researchers in France, Canada, Japan and the USSR are also presented. Author

N91-24090# Wichita State Univ., KS. Dept. of Industrial Engineering.
COGNITIVE PERFORMANCE CAPABILITIES IN THE COCKPIT
Randall M. Chambers and Mihriban Whitmore *In its* Kansas Aviation Review 1991 p 14-20 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

N91-24165# Wichita State Univ., KS.
HUMAN FACTORS COCKPIT: A SYSTEM AND HUMAN FACTORS PROGRAM TO ENHANCE SAFETY AND EFFICIENCY IN SINGLE PILOT IFR AND TERMINAL AREA OPERATIONS
Randall M. Chambers, Paul York, M. Gawad Nagati, and David Ellis *In its* Program Plans for Aviation Safety Research Dec. 1990 11 p (For primary document see N91-24157 16-03)
Avail: NTIS HC/MF A04

N91-24604*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CETA TRUCK AND EVA RESTRAINT SYSTEM
David C. Beals and Wayne R. Merson (Lockheed Engineering and Sciences Co., Hampton, VA.) *In* JPL, The 25th Aerospace Mechanisms Symposium May 1991 p 1-14 (For primary document see N91-24603 16-39)
Avail: NTIS HC/MF A15 CSCL 05H

N91-24665# Meteorological Satellite Center, Tokyo (Japan).
ADDED INFORMATION BY MAN-MACHINE INTERACTIVE OPERATION OF THE SCIC
Yoshihiko Ando *In its* Meteorological Satellite Center Technical Note, No. 21, 1990 Dec. 1990 p 33-46 In JAPANESE; ENGLISH summary (For primary document see N91-24661 16-42)
Avail: NTIS HC/MF A05

55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

N91-24745*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PARALLEL COMPUTING USING A LAGRANGIAN FORMULATION
May-Fun Liou and Ching Yuen Loh 1991 20 p Presented at the Parallel CFD Conference, Stuttgart, Fed. Republic of Germany, 10-12 Jun. 1991; sponsored by NASA, CONVEX, CRAY, debis, GAMNI-SMAI, IBM, INTEL, nCUBE, SIEMENS-NIXDORF, and Thinking Machines
(NASA-TM-104446; E-6286; NAS 1.15:104446) Avail: NTIS HC/MF A03 CSCL 12A

A new Lagrangian formulation of the Euler equation is adopted for the calculation of 2-D supersonic steady flow. The Lagrangian formulation represents the inherent parallelism of the flow field better than the common Eulerian formulation and offers a competitive alternative on parallel computers. The implementation of the Lagrangian formulation on the Thinking Machines Corporation CM-2 Computer is described. The program uses a finite volume, first-order Godunov scheme and exhibits high accuracy in dealing with multidimensional discontinuities (slip-line and shock). By using

this formulation, a better than six times speed-up was achieved on a 8192-processor CM-2 over a single processor of a CRAY-2. Author

N91-24746*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
SEMIANNUAL REPORT, 1 OCTOBER 1990 - 31 MARCH 1991 Final Report
May 1991 64 p
(Contract NAS1-18605)
(NASA-CR-187569; NAS 1.26:187569) Avail: NTIS HC/MF A04 CSCL 12A

Research conducted at the Institute for Computer Applications in Science and Engineering in applied mathematics, numerical analysis, and computer science is summarized. Author

60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

N91-24747# National Inst. of Standards and Technology, Gaithersburg, MD.
AN OVERVIEW OF THE PRODUCT DATA HYPERSTANDARD CD-ROM PROTOTYPE
Sandy Ressler Nov. 1990 16 p
(PB91-132258; NISTIR-4470) Avail: NTIS HC/MF A03 CSCL 09B

The contents of the product data hyperstandard CD-ROM prototype that contains information related to product data standards are described. Hyperstandard is a generic term describing the application of hypertext and multimedia technologies to standards in general. The CD-ROM contains both browsers for perusing the documents and a number of other items of interest to the product data community. These include: IGES version 5; the CALS specifications; preliminary the standard for the exchange of product model data (STEP) drafts, product data exchange using STEP (PDES), Inc. technical documents; the NIST PDES Toolkit; and other miscellaneous pieces of information. The sources of data for the document browsers on the CD-ROM prototype were the original electronic documents used to print those documents. All of these data combined should serve as a useful repository of information for the community of technical experts developing product data standards. This variety of information was assembled to demonstrate that CD-ROM's are a convenient and cost-effective medium for use by the people involved in product data standardization efforts. GRA

N91-24748# Stanford Univ., CA. Computer Systems Lab.
MICROSUPERCOMPUTERS: DESIGN AND IMPLEMENTATION Semiannual Report, Oct. 1990 - Mar. 1991
John L. Hennessy and Mark A. Horowitz Mar. 1991 28 p
(Contract N00014-87-K-0828)
(AD-A233155) Avail: NTIS HC/MF A03 CSCL 12/6

Some topics of discussion are as follows: (1) Executive Summary, Goals and Accomplishments; (2) Technical Progress - 2.1 Parallel Processor Architecture; 2.2 Parallel Software; 2.3 Uniprocessor Architecture; 2.4 Computer Aided Design; (3) Publications, Presentations, Reports. GRA

N91-24749 Department of the Navy, Washington, DC.
HIGH ACCURACY DIGITAL ACOUSTO-OPTIC MATRIX COMPUTER Patent
Ravindra A. Athale, inventor (to Navy) 22 Jan. 1991 8 p
Filed 22 Feb. 1985
(AD-D014842; US-Patent-4,986,640; US-Patent-Appl-SN-704454; US-Patent-Class-350-358) Avail: US Patent and Trademark Office CSCL 12/6

A digital acousto-optic device for performing vector-matrix multiplication is disclosed. The device comprises two multi-transducer acousto-optic cells imaged onto each other. The first cell receives the elements of the input vector in parallel. The second receives the elements of sequential row vectors of the matrix in parallel. The data in the two cells act to modulate a light beam passing there through. The modulated light beam is detected to produce an output data stream containing the elements of the output vector. The invention uses binary coded data for high accuracy. GRA

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

N91-24750 Tel-Aviv Univ. (Israel). Dept. of Computer Science.
AN OPTIMAL 0(LOG LOG n) TIME PARALLEL STRING MATCHING ALGORITHM M.S. Thesis
Dany Breslauer Sep. 1988 19 p
(ITN-90-85019) Copyright Avail: Tel-Aviv Univ., Library of Exact Sciences, Ramat Aviv 69978, Israel

An optimal 0(log log n) time parallel algorithm for string matching on Concurrent Read Concurrent Write-Parallel Random Access Machine (CRCW-PRAM) is presented. It improves previous results of (G) and (V). ISA

N91-24751 Tel-Aviv Univ. (Israel). Dept. of Computer Science.
METHODS FOR CHANNEL ROUTING AND MODIFICATIONS OF THE YACR2 ALGORITHM M.S. Thesis
Ronen Keinan Nov. 1988 64 p In HEBREW; ENGLISH summary
(ITN-90-85020) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel, pricing information obtainable from document source

Some of the common methods are reviewed for the channel routing problem. One of the algorithms is implemented, the symbolic channel router YACR2 (Yet Another Channel Router), adopting the main ideas of the algorithm and adding some modifications. The modifications include: (1) Smart mechanism, handling long chains in the vertical constraints graph; (2) Compact grid based on a via to line clearance; (3) Application to non-rectangular channels; (4) Pre-routing or obstacles treatment; and (5) Local improvements for the heuristics and for the maze routing phase. The improved algorithm was tested on a large number of real life examples and performs better in terms of area used, number of vias and total wires length. ISA

N91-24752 Tel-Aviv Univ. (Israel). Dept. of Computer Sciences.
ON TRANSFORMED PATTERN MATCHING PROBLEMS M.S. Thesis
Meir Yedidia Aug. 1988 29 p
(ITN-90-85021) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel, pricing information obtainable from document source

The classic pattern matching problem is extensively discussed in the literature. Most of the proposed algorithms consist of a pattern analysis stage followed by a text analysis stage. This problem can be extended to the case in which the pattern is modified by a transformation (one of a family of transformations). An optimal speedup, logarithmic time parallel algorithm is introduced to the text analysis stage of such extension: the k-linear transformation problem. The 2-D extension is also discussed, both for exact occurrences and minimal distance occurrences. ISA

N91-24753*# General Digital Industries, Inc., Huntsville, AL.
SOFTWARE TECHNOLOGY TESTBED SOFTPANEL PROTOTYPE Final Report, May 1988 - Feb. 1991
19 Feb. 1991 70 p
(Contract NAS8-37680)

(NASA-CR-187913; NAS 1.26:187913) Avail: NTIS HC/MF A04 CSCL 09B

The following subject areas are covered: analysis of using Ada for the development of real-time control systems for the Space Station; analysis of the functionality of the Application Generator; analysis of the User Support Environment criteria; analysis of the SSE tools and procedures which are to be used for the development of ground/flight software for the Space Station; analysis if the CBATS tutorial (an Ada tutorial package); analysis of Interleaf; analysis of the Integration, Test and Verification process of the Space Station; analysis of the DMS on-orbit flight architecture; analysis of the simulation architecture. Author

N91-24754*# Purdue Univ., West Lafayette, IN. School of Electrical Engineering.

HIERARCHICAL CLASSIFICATION IN HIGH DIMENSIONAL NUMEROUS CLASS CASES

Byungyong Kim and D. A. Landgrebe Jun. 1990 115 p
(Grant NAGw-925)
(NASA-CR-188210; NAS 1.26:188210; TR-EE-90-47) Avail: NTIS HC/MF A06 CSCL 09B

As progress in new sensor technology continues, increasingly high resolution imaging sensors are being developed. These sensors give more detailed and complex data for each picture element and greatly increase the dimensionality of data over past systems. Three methods for designing a decision tree classifier are discussed: a top down approach, a bottom up approach, and a hybrid approach. Three feature extraction techniques are implemented. Canonical and extended canonical techniques are mainly dependent upon the mean difference between two classes. An autocorrelation technique is dependent upon the correlation differences. The mathematical relationship between sample size, dimensionality, and risk value is derived. Author

N91-24755 Politecnico di Milano (Italy). Dipt. di Elettronica.

IDENTIFICATION OF MODEL STRUCTURE VIA QUALITATIVE SIMULATION

G. Guariso, L. Nisoli, A. Rizzoli, and H. Werthner (Technische Univ., Vienna, Austria) 1990 31 p Sponsored by Italian Ministry of Public Education, and CNR
(Rept-90-040; ETN-91-99086) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

Different approaches and programs for qualitative simulation are revised to illustrate the characteristic features of QUALSIM, an object oriented package for supporting the identification of the structure of dynamic systems. The package is based on a qualitative interface and a stochastic calculus using variable ranges defined in the real number space. The intuitive way of defining variables and connections and the possibility of avoiding the definition of equations linking the variables allow the package to be used as a fast protyping model and an educational tool. The identification of a model of lake eutrophication is shown as an example. ESA

N91-24756 Politecnico di Milano (Italy). Dipt. di Elettronica.

A CAD SYSTEM TO DESIGN LOGIC CONTROLLERS

F. Bignotto (Master School CEFRIEL, Milan, Italy), L. Ferrarini, and C. Maffezzoni 1990 17 p
(Rept-90-042; ETN-91-99087) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

Logic controllers play an extremely important role in the control of both continuous and discrete systems. However, the design process of logic controllers is not supported yet by an integrated set for CAD/CAE (Computer Aided Design/Computer Aided Engineering) tools for their specification, programmation, validation and simulation. In addition, there is no standard consolidated in the international community. A formalism based on a special version of Petri nets, able to model any kind of logic controllers without ambiguity and to give theoretical and practical tools to formally verify the basic properties that a logic controller must possess is proposed. The realization of a prototype CAD/CAE environment to design logic controllers is described. An applicative example is shown concerning the control of a manufacturing cell. ESA

N91-24757*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

ALDAS USER'S MANUAL

Michael E. Watts Apr. 1991 49 p
(NASA-TM-102831; A-90182; NAS 1.15:102831) Avail: NTIS HC/MF A03 CSCL 09B

The Acoustic Laboratory Data Acquisition System (ALDAS) is an inexpensive, transportable means to digitize and analyze data. The system is based on the Macintosh 2 family of computers, with internal analog-to-digital boards providing four channels of simultaneous data acquisition at rates up to 50,000 samples/sec. The ALDAS software package, written for use with rotorcraft acoustics, performs automatic acoustic calibration of channels, data display, two types of cycle averaging, and spectral amplitude analysis. The program can use data obtained from internal analog-to-digital conversion, or discrete external data imported in ASCII format. All aspects of ALDAS can be improved as new hardware becomes available and new features are introduced into the code. Author

N91-24758*# Old Dominion Univ., Norfolk, VA. Dept. of Computer Science.

A SOFTWARE DEVELOPMENT AND EVOLUTION MODEL BASED ON DECISION-MAKING Final Report, period ending 31 Jan. 1991

J. Christian Wild, Jinghuan Dong, and Kurt Maly Jun. 1991 10 p Presented at the Third International Conference on Software and Knowledge Engineering, Skokie, IL, Jun. 1991
(Grant NAG1-966)
(NASA-CR-187889; NAS 1.26:187889) Avail: NTIS HC/MF A02 CSCL 09B

Design is a complex activity whose purpose is to construct an artifact which satisfies a set of constraints and requirements. However the design process is not well understood. The software design and evolution process is the focus of interest, and a three dimensional software development space organized around a decision-making paradigm is presented. An initial instantiation of this model called 3DPM(sub p) which was partly implemented, is presented. Discussion of the use of this model in software reuse and process management is given. Author

N91-24759*# Cornell Univ., Ithaca, NY. Dept. of Computer Science.

USING CONSISTENT SUBCUTS FOR DETECTING STABLE PROPERTIES

Keith Marzullo and Laura Sabel May 1991 13 p
(Contract NAG2-593; N00140-87-C-8904)
(NASA-CR-187844; NAS 1.26:187844; TR-91-1205) Avail: NTIS HC/MF A03 CSCL 09B

A general algorithm is presented for detecting whether a property holds in a distributed system, where the property is a member of a class called the locally stable properties. The algorithm is based on a decentralized method of constructing a maximal subset of the local states that are mutually consistent, which in turn is based on a weakened version of vector time stamps. The utility of the algorithm is demonstrated by using it to derive some specialized property-detection protocols, including two previously known protocols that are known to be efficient. Author

N91-24760# Ada Joint Program Office, Arlington, VA.

Ada PROGRAMMING SUPPORT ENVIRONMENT (APSE) EVALUATION AND VALIDATION (E AND V) TEAM Final Report

1991 44 p
(AD-A232075) Avail: NTIS HC/MF A03 CSCL 12/5

This report has been prepared to reflect the current state of the Ada programming support environment (APSE) evaluation and validation (E and V) technology as developed by the E and V Project, and the recommendations of the E and V team regarding potential future directions. Perspectives regarding future directions for the E and V Reference System, the Ada compiler evaluation capability (ACEC), the common APSE interface set (CAIS)

implementation validation capability (CIVC), and APSE E and V in general are presented. The final team recommendations are given. GRA

N91-24761# Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
AN EVALUATION OF CONCURRENT PRIORITY QUEUE ALGORITHMS
Qin Huang Feb. 1991 86 p
(Contract N00014-89-J-1988)
(AD-A232288; MIT/LCS/TR-497) Avail: NTIS HC/MF A05
CSCL 12/5

The priority queue is a fundamental data structure that is used in a large variety of parallel algorithms, such as multiprocessor scheduling and parallel best-first search of state-space graphs. This thesis addresses the design and experimental evaluation of two novel concurrent priority queues: a parallel Fibonacci heap and a concurrent priority pool, and compares them with the concurrent binary heap. The parallel Fibonacci heap is based on the sequential Fibonacci heap, which is theoretically the most efficient data structure for sequential priority queues. This scheme not only preserves the efficient operation time bounds of its sequential counterpart, but also has very low contention by distributing locks over the entire data structure. The experimental results show its linearly scalable throughput and speedup up to as many processors as tested (currently 18). A concurrent access scheme for a doubly linked list is described as part of the implementation of the parallel Fibonacci heap. The concurrent priority pool is based on the concurrent B-tree and the concurrent pool. The concurrent priority pool has the highest throughput among the priority queues studied. Like the parallel Fibonacci heap, the concurrent priority pool scales linearly up to as many processors as tested. The priority queues are evaluated in terms of throughput and speedup. Some applications of concurrent priority queues such as the vertex cover problem and the single source shortest path problem are tested. GRA

N91-24762# Wisconsin Univ., Madison. Dept. of Computer Sciences.
PARALLEL SOLUTION OF VERY LARGE SPARSE LINEAR PROGRAMS Final Report, 1 Jun. 1986 - 31 May 1990
Olvi L. Mangasarian 31 May 1990 15 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Grant AF-AFOSR-0172-86; AF Proj. 2304)
(AD-A232764; AFOSR-91-0146TR) Avail: NTIS HC/MF A03
CSCL 12/4

The principal area of research was the parallel solution of large sparse linear programs. A number of new algorithms with increased performance were developed and tested for special cases. Abstracts of the papers written under this support grant are presented. GRA

N91-24763# Wisconsin Univ., Madison. Dept. of Industrial Engineering.
COMPUTATION AND THEORY IN NONLINEAR OPTIMIZATION Final Report, 15 Nov. 1988 - 14 Nov. 1990
Stephen M. Robinson 11 Jan. 1991 6 p
(Grant AF-AFOSR-0058-89)
(AD-A232908; AFOSR-91-0163TR) Avail: NTIS HC/MF A02
CSCL 12/4

The research objectives of this program were: (1) to extend the theory base in nonsmooth analysis; (2) to apply that theory to develop algorithms that extend the range of optimization problems that can be solved; (3) to improve the understanding of convergence behavior in stochastic optimization; and (4) to apply that understanding to the design and analysis of improved algorithms for solving optimization problems in important application areas such as manufacturing. GRA

N91-24764# Carnegie-Mellon Univ., Pittsburgh, PA. Graduate School of Industrial Administration.
MATHEMATICAL PROGRAMMING AND LOGICAL INFERENCE Final Report, 15 Jul. 1987 - 14 Oct. 1990
Egon Balas, Gerard Cornuejols, and John Hooker Dec. 1990 17 p
(Grant AF-AFOSR-0292-87)
(AD-A232955; AFOSR-91-0179TR) Avail: NTIS HC/MF A03
CSCL 12/4

The object of this research is to develop new and effective methods for logical inference that are based on mathematical programming. We investigated fast packing and covering algorithms as well as polyhedral properties of these problems. We identified classes of covering and inference problems that can be solved by linear programming. We also obtained several results in both deductive and inductive logic. In the area of deductive logic, we developed branch-and-cut algorithms for inference in propositional logic, generalized the notion of a Horn problem (widely used in expert systems), designed a new algorithm for verifying logic circuits, found new connections between propositional logical and cutting plane theory, developed an inference method for a generalized belief net (Bayesian logic), and proposed new computational methods for Dempster Shafer theory. In inductive logic, we proposed a new, regression based method for generating rules for an expert system. GRA

N91-24765# California Univ., Los Angeles.
NATURAL LANGUAGE SOURCEBOOK Database Report, 1 Jul. 1986 - 31 Dec. 1990
Walter Read, Michael Dyer, Eva L. Baker, Patricia Mutch, and Frances A. Butler 1990 276 p
(Contract N00014-86-K-0395)
(AD-A233005) Avail: NTIS HC/MF A13 CSCL 05/7

The Natural Language Sourcebook was a research component in the development of the Artificial Intelligence Measurement System (AIMS). The Sourcebook is a compilation on 197 processing problems addressed or handled by intelligent computer systems. The problems, culled from the literature in artificial intelligence, computational linguistics, and cognitive psychology, have been classified into a scheme with an artificial intelligence bent and cross-referenced to companion schemes one with a linguistic and one with a cognitive psychological perspective on the type of issues reflected in the problems. Each entry in the Sourcebook, called and exemplar, consists of: (1) one or more sentences, a fragment of dialogue or a piece of text which illustrates a conceptual issue, (2) a reference, and (3) a discussion of the problem a system might have in understanding the example. An electronic version of the Sourcebook database was developed in a Hypercard environment to facilitate use of the multiple classification schemes (Herl, September 1990). The Hypercard version of the Sourcebook is accompanied by a user's manual (Herl, August 1990). GRA

N91-24766# Rome Air Development Center, Griffiss AFB, NY.
KNOWLEDGE-BASED SOFTWARE ASSISTANT (KBSA) TECHNOLOGY TRANSFER CONSORTIUM: STATUS REPORT 1
Donald M. Elefante Dec. 1990 46 p
(AF Proj. 2532)
(AD-A233035; RADC-TR-90-414) Avail: NTIS HC/MF A03
CSCL 12/5

RADC's Knowledge Based Software Assistant (KBSA) program sprung from a 1983 Rome Air Development Center (RADC) technical report entitled, Report on a Knowledge Based Software Assistant. That document integrated key ideas on how artificial intelligence might be used to design, develop and maintain software over the complete life cycle. The report's general intent was to suggest a program that could bring an order-of-magnitude productivity complex systems involving mission-critical computer resources. Since then, RADC has initiated and completed the first of three multiple-contract phases intended to develop both a KBSA and its supporting technologies. The second phase is well under way. The success of the KBSA program has meant that RADC has had to devise effective measures for transferring its early technology to potential defense contractors. Thus, the Knowledge Based Software Assistant Technology Transfer Consortium (KBSA TTC) was inaugurated. Because the consortium was founded on quid-pro-quo exchanges not directly involving money, this technology transfer approach has been as much of an experiment

in method as an exercise in necessity. This report takes stock of the consortium's experiences and achievements over the first 1-1/2 years. GRA

N91-24767# Logistics Management Inst., Bethesda, MD.
A GUIDE TO EDI TRANSLATION SOFTWARE Final Report
Harold L. Frohman 1991 121 p
(Contract MDA903-85-C-0139)
(AD-A233053; LMI-PL005R1) Avail: NTIS HC/MF A06 CSCL 12/5

This guide identifies and provides details on 72 commercially available electronic data interchange (EDI) translation software packages. It was developed for use by the Military Departments and Defense agencies as they procure EDI translation software packages in support of the Department of Defense's (DoD's) EDI program for transportation. However, other DoD entitles with an EDI program should find this guide useful. This guide assesses the key features of each package, details a list of functions available in a particular software package, and highlights those features required to meet the EDI needs of Defense transportation in specific operating environments. GRA

N91-24768# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
DESIGN AND IMPLEMENTATION OF REAL-TIME COMPUTER COORDINATED FORCE ACTUATING SYSTEM WITH MULTI-INPUT/OUTPUT
Xiaobin Cai, Guanzhong Dai, and Tiesheng Jia 7 Nov. 1990 18 p Transl. into ENGLISH from Xiyou Yu Kongzhi (Peoples Rep. of China), no. 4, 1989 p 12, 13-17
(AD-A233114; FTD-ID(RS)T-0166-90) Avail: NTIS HC/MF A03 CSCL 01/4

A design method is presented for triple point real time coordinated control loading of an electrohydraulic servosystem; with a conditional output feedback compensator, the system is relatively simple in its coordinated structure. The coordinated controller is used to alter the lift in variable sweptback wings in a loading system. As indicated by 5000 repeated tests, the method presented is feasible; the experimental results are excellent. Practical value is apparent in the designing of a stationary and moving loading type real time computer force actuating control system. GRA

N91-24769# Information Systems and Technology Center, Wright-Patterson AFB, OH. Ada Validat Ion Facility.
Ada COMPILER VALIDATION SUMMARY REPORT: CERTIFICATE NUMBER: 900726W1.11019, VERDIX CORPORATION, VADS PRIME EXL/320, UNIX SYSTEM V/386 3.2, VADA-110-3232, VERSION 6.0, PRIME EXL/320 GREATER THAN OR EQUAL TO PRIME EXL/320 Final Report
22 Jan. 1991 38 p
(AD-A233122) Avail: NTIS HC/MF A03 CSCL 12/5

The Ada implementation described above was tested according to the Ada Validation Procedure (Pro90) against the Ada Standard (Ada83) using the current Ada Compiler Validation Capability (ACVC). An account is given of the testing of this Ada implementation. GRA

N91-24770# Information Systems and Technology Center, Wright-Patterson AFB, OH. Ada Validat Ion Facility.
Ada COMPILER VALIDATION SUMMARY REPORT: CERTIFICATION NUMBER: 900228W1.11001, VERDIX CORPORATION, VADA-110-6161, VERSION 6.0.2, DECSTATION 3100 GREATER THAN OR EQUAL TO DECSTATION 3100 Final Report
16 Jan. 1991 34 p
(AD-A233134) Avail: NTIS HC/MF A03 CSCL 12/5

The Ada implementation described above was tested according to the Ada Validation Procedures (Pro90) against the Ada Standard (Ada83) using the current Ada Compiler Validation Capability (ACVC). The Validation Summary Report (VSR) gives an account of the testing of the Ada implementation. GRA

N91-24771# Air Univ., Maxwell AFB, AL. Airpower Research Inst.
AN ANALYSIS OF TRUSTED COMPUTER EVALUATION AND CERTIFICATION
Eric C. Lewallen Dec. 1990 40 p
(AD-A233145; AU-ARI-89-13) Avail: NTIS HC/MF A03 CSCL 12/8

At the very heart of the war-fighting capability is computer systems. These machines are depended upon as a key force multiplier to defeat a larger and more heavily armed adversary. Yet these machines are vulnerable to many security threats. Progress in developing and acquiring trusted computer systems-hardware and software together that enforce a security policy, has been slow over the past 10 years, providing users with few products. Clearly this situation must improve. The command, control, and communication systems need trusted computer systems to counteract the growing threat to the systems and provide a multilevel secure processing capability. The author has thoroughly examined the trusted computer evaluation and certification processes. Although there are significant problems in developing and acquiring trusted systems, an increase in interest and support is revealed at all levels to resolve this important issue. Recommendations are made which address actions the Air Force can take to assist computer security personnel in the difficult job of developing and acquiring these systems. GRA

N91-24772# Army Military Personnel Center, Alexandria, VA.
SELECTION CRITERIA FOR ALTERNATE SOFTWARE LIFE CYCLE PROCESS MODELS Final Report M.S. Thesis
Linda C. Alexander May 1990 129 p
(AD-A233228) Avail: NTIS HC/MF A07 CSCL 12/5

The importance of selecting an appropriate software life cycle process model for software development projects is discussed. Software life cycle process models can be fit into a hierarchy at different levels of abstraction. The conventional, incremental and evolutionary process models are classified at the highest level of abstraction in this hierarchy. At the next level are the waterfall, hybrid prototyping, operational specification, and transformational process models. This hierarchy divided the selection of a process model into two steps. To support the selection of a process model for a project, a set of criteria and their values are defined. Under each criterion, the most appropriate process model is determined. These selections are partially verified by looking at a set of project case studies. An example of the use of the criteria for evaluating a project and then selecting a process model is given. GRA

N91-24773# Joint Data Systems Support Center, Washington, DC.
SOFTWARE REQUIREMENTS SPECIFICATION FOR THE MAPPING AND GRAPHIC INFORMATION CAPABILITY (MAGIC). VOLUME 5: GRAPHIC EDITOR CSCI
David W. Hall 1 Dec. 1990 46 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(AD-A233266; DCA/JDSSC-SRS-1-90-Vol-5) Avail: NTIS HC/MF A03 CSCL 12/5

The Graphic Editor CSCI (Computer Software Configuration Item) provides an interactive capability to create new slides, and edit multiple slides simultaneously on the WWMCCS Workstation (WWS) through the use of freehand drawing functions, polygon manipulation, and other graphic editing techniques. The resultant slides may be viewed singly by the user in a MAGIC session or incorporated into a slide presentation with other slides. This Software Requirements Specifications (SRS) specifies the requirements allocated to the Graphic Editor CSCI and enables the government to assess whether or not the completed CSCI complies with those requirements. Upon Government approval and authentication, the SRS becomes the Allocated Baseline for the CSCI and is used by the contractor as the basis for development and formal testing of the CSCI. As such, this SRS specifies the complete list of requirements (functional, interface, performance, qualification, etc.) for the Graphic Editor CSCI. It includes requirements for programming design, adaption, quality factors,

and traceability of the CSCI, as well as delivery preparation and ancillary notes, such as references and terms and abbreviations. GRA

N91-24774# California Univ., Los Angeles.
HYPERCARD DATABASE FOR THE NATURAL LANGUAGE SOURCEBOOK (USER'S MANUAL) Project Report No. 9, 1 Feb. 1989 - 31 Aug. 1990
Howard Herl Aug. 1990 44 p
(Contract N00014-86-K-0395; NR Proj. RR0-4206)
(AD-A233307) Avail: NTIS HC/MF A03 CSCL 12/5

This manual provides a step-by-step description of how to access information in the HyperCard database version of the Natural Language Sourcebook (Read, Dyer, Baker Mutch, Butler, Quilici, and Reeves, 1990). The chapters in the manual include: (1) An Introduction to the Sourcebook, (2) Browsing Through the Database, (3) Searching for Exemplars and Cross References, and (4) On line Assistance. The step-by-step instructions in the manual are graphically augmented with screen displays taken from the database. GRA

N91-24775# Washington Univ., Seattle. Dept. of Applied Mathematics.
NUMERICAL ALGORITHMS FOR PARALLEL COMPUTERS Final Report, 1 May 1986 - 31 Mar. 1990
Loyce M. Adams 31 Mar. 1990 10 p
(Grant AF-AFOSR-0154-86; AF Proj. 2304)
(AD-A233348; AFOSR-91-0181TR) Avail: NTIS HC/MF A02 CSCL 12/1

Progress was made on five fronts: analysis of parallel iterative methods using Fourier analysis techniques; preconditioners for linear systems on parallel architectures; numerical grid generation algorithms for fighter aircraft configurations; parallel domain decomposition algorithms for symmetric eigenvalue problems; and parallel language design issues from an applications point of view. Two Ph.D. theses were completed. GRA

N91-24776# Naval Research Lab., Washington, DC.
ANALYTIC METHODS OF IMAGE REGISTRATION: DISPLACEMENT ESTIMATION AND RESAMPLING Final Report, Jan. 1985 - Jan. 1990
A. Schaum and M. McHugh 28 Feb. 1991 36 p Sponsored by Office of Naval Technology, Arlington, VA
(AD-A233385; NRL-9298) Avail: NTIS HC/MF A03 CSCL 19/5

Registration algorithms are developed and evaluated by using oversampled scanning imagery directly and staring imagery with a subpixel autocorrelation model. A Fourier transform-based method, Phase Correlation, is enhanced to remove edge effects, to accommodate nonintegral shifts, and to resolve ambiguity in the interpretation of its output. The result is shown to be accurate over a wide range of misregistration and to be capable of detecting cloud parallax and other relative motion effects. A family of gradient based methods is also derived and is shown to include older methods: the Image Displacement Estimation Algorithm (IDEA) and the Gradient Estimation Method (GEMS). One member of the family, the Canonical Gradient Estimate (CAGRE), proves to be generally superior, as long as the noise-to-clutter ratio is not unusually large compared to typical values for Earth backgrounds. Resampling methods are also tested: linear, spline, phase-shifting, and cubic convolution; cubic convolution performs marginally better for all values of shift. The net result here is a substantial improvement in the state of the art of analytic image registration, which may permit the use of frame differencing as a moving-target indicator in the most cluttered natural backgrounds. Author (GRA)

N91-24777# Defence Research Establishment Atlantic, Dartmouth (Nova Scotia).
USER'S MANUAL FOR PROGRAM MAVART
Edward L. Skiba and Garfield W. McMahon Jan. 1991 56 p Revised
(AD-A233426; DREA-TM-91/201-Rev) Avail: NTIS HC/MF A04 CSCL 12/5

This document is the first in a set of documents that provides information on the finite element model for the analysis of vibration and acoustic radiation of transducers (MAVART). The set comprises: (1) a user's manual for program MAVART; (2) theoretical manual for program MAVART; and (3) examples manual for program MAVART. The program MAVART is at the Defense Research Establishment Atlantic (DREA) and has been developed under several research contracts to Canadian industry from 1976 to the present (1990). The original set of documents formed Contractor Report DREA CR/87/442 and they are now being extensively revised. The examples manual has already been revised, and re-issued as Technical Memorandum DREA TM 90/204. This user's manual provides detailed reference information for users of MAVART, including input data specifications and a description of the element library. GRA

N91-24778# Defence Research Establishment, Ottawa (Ontario).
AN EVALUATION OF THE HSPICE/RADSPICE CIRCUIT SIMULATION CODE SYSTEM
G. T. Pepper and R. E. Stone Nov. 1990 26 p In ENGLISH and FRENCH
(AD-A233429; DREO-TN-90-33) Avail: NTIS HC/MF A03 CSCL 12/5

The RADSPICE computer code (an optional yet integral component of the HSPICE circuit simulation computer code, copyright META-SOFTWARE Inc.) can be used to simulate radiation effects in electronic circuits. This report has been produced to summarize the capabilities of the RADSPICE code and to increase the amount of detailed documentation available to the RADSPICE user. A general description of RADSPICE (including how to construct electronic circuit network listings or 'netlists') has been provided and the range of applications, ease of use (including manufacturer support available to users) and accuracy of results obtained with RADSPICE have been discussed. It has been found that effective use of HSPICE/RADSPICE demands much from the user. The user must be the code system, be able to apply correctly these approximations and assumptions in creating a numerical model of the device(s) to be simulated and finally, be sophisticated enough to interpret accurately the results of the simulation. GRA

N91-24779# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
NEW IMAGE-TRACKING ALGORITHM FOR FUZZY-RELAXATION MATCHING OF POINT PATTERNS
Zhili Liu, Yihe Yang, and Weizhen Zhou 29 Oct. 1990 16 p Transl. into ENGLISH from Hongwai Yanjiu (Peoples Rep. of China), v. 8, no. 5, 1989 p 349-354
(AD-A233506; FTD-ID(RS)T-0709-90) Avail: NTIS HC/MF A03 CSCL 17/5

This paper presents a new image tracking algorithm for fuzzy-relaxation matching of point patterns. The algorithm is insensitive to geometric distortions of the whole, to inaffine distortions to a certain extent, and to multi- and few-point distortions. The presentation of the new-matching-vector set and the standard set greatly reduces computation time. As shown by simulation results of multi target infrared image array in the sea, the algorithm is adaptable not only to a single target, but also to multiple targets in acquisition, locating, and tracking. GRA

N91-24780# Auburn Univ., AL. Dept. of Computer Science and Engineering.
DISTRIBUTED MULTI-AGENT PLANNING Final Report, 4 Jun. - 6 Jul. 1990
William B. Day Dec. 1990 31 p
(Contract F30602-88-D-0026)
(AD-A233522; RADC-TR-90-410) Avail: NTIS HC/MF A03 CSCL 12/5

This report investigates methods for extending the Distributed Datalog (DDL) system to allow OR-parallelism. A synopsis of implementation issues is given along with a summary of previous attempts at OR-parallelism. Two methods are examined for possible

incorporation into the DDL. This effort also examines the application of the DDL to distributed multi-agent planning. GRA

N91-24781# Colorado Univ., Boulder. Dept. of Computer Science.
CENTRALIZED AND DISTRIBUTED DYNAMIC SCHEDULING FOR ADAPTIVE, PARALLEL ALGORITHMS
Sharon L. Smith and Robert B. Schnabel 14 Feb. 1991 31 p
(Contract DAAL03-88-K-0086; AF-AFOSR-0109-90; NSF CDA-89-22510)
(AD-A233557; CU-CS-516-91; ARO-24923.8-MA) Avail: NTIS HC/MF A03 CSCL 12/5

We examine a set of dynamic scheduling techniques for parallel adaptive algorithms in a distributed computational environment. We consider three basic scheduling approaches: centralized scheduling, which uses a master-slave model of computation; distributed scheduling, which uses local information about processor workload to determine when tasks should be requested from or sent to other processors; and a new approach that we refer to as centralized mediation, that uses aspects of both centralized and distributed scheduling. We use both distributed implementation and simulation to examine the performance and scalability of these three scheduling approaches when applied to a parallel adaptive algorithm for solving the global optimization problem. In these experiments, the new centralized mediation approach appears to provide the best combination of robustness, efficiency, and ease of implementation. GRA

N91-24782# Naval Ocean Systems Center, San Diego, CA.
BMD/Ada BIT-ORIENTED MESSAGE DEFINER: A TOOL TO DEFINE BIT-ORIENTED MESSAGES IN Ada Final Report, Oct. 1989 - Sep. 1990
R. H. Mumm and S. A. Parker Dec. 1990 30 p
(AD-A233576; NOSC/TR-1384) Avail: NTIS HC/MF A03 CSCL 12/5

The Bit-Oriented Message Definer (BMD) is a portable interactive software tool for automatically generating Ada source code that defines bit-oriented messages. The BMD can help reduce the development costs for Ada software that process bit-oriented messages. Appropriate applications include command and control systems such as the Command and Control Processor (C2P) Shadow Project, which is being directed by Naval Ocean Systems Center (NOSC), and the Ship Gridlock Project, which is being conducted at the Naval Surface Warfare Center (NSWC), Dahlgren, VA. The BMD executes on the Vax Ada, Sun Telesoft Ada, and Sun Alsys compilers and generates source codes that will execute in at least five different target environments. GRA

N91-24783# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
A 3D-OBJECT RECONSTRUCTION SYSTEM INTEGRATING RANGE-IMAGE PROCESSING AND RAPID PROTOTYPING
Carlos Cerrada, Katsushi Ikeuchi, Lee Weiss, and Raj Reddy Dec. 1990 39 p
(AD-A233577; CMU-RI-TR-90-32) Avail: NTIS HC/MF A03 CSCL 12/9

This paper describes a system which integrates computer vision and rapid manufacturing technologies to scan physical objects and to replicate the reconstructed shapes as steel faced dies using shaping deposition processes. A light range finder is used to scan the three dimensional data of the object. Range data is then processed in order to generate a solid model representation. A simulation process is incorporated to display the reconstructed object so that data quality is checked and refined before proceeding to the fabrication process, as well as viewing object in alternative materials and colors. The computer model is then replicated as a plastic prototype with stereolithography. Finally, this prototype is used as a pattern in a thermal spray process to build a metal-faced die replica of the original object. The system is demonstrated by scanning a human face which is then replicated as a stainless-steel sculpture. GRA

N91-24784# Brunel Univ., Uxbridge (England).
COMPUTER ASSISTED ANALYSIS AND MODELLING OF STRUCTURED PROBLEMS Final Report No. 7, Apr. - Nov. 1990
E. Hadjiconstantinou and G. Mitra 19 Dec. 1990 3 p
(Contract DAJA45-87-C-0003; DA Proj. 1L1-61102-BH-57)
(AD-A233592; R/D-5338-CC-03) Avail: NTIS HC/MF A01 CSCL 12/4

In this project we have studied the scope and possible application of computer based tools which can support modelling of mathematical optimization problems. We initially investigated the method of transforming general nonlinear programming problems to variable separable form. Subsequently more research effort was directed towards developing a systematic procedure for transforming propositional calculus statements into integer and mixed integer programming models. Computer implementation of such procedures in order to achieve automatic reformulation has been an important consideration. GRA

N91-24785# Pacific Northwest Lab., Richland, WA.
COMPUTING AND INFORMATION SCIENCES PRELIMINARY ENGINEERING DESIGN STUDY
J. O. Schroeder, E. W. Pearson, J. J. Thomas, J. W. Brothers, W. K. Campbell, D. M. DeVaney, D. R. Jones, R. J. Littlefield, and M. J. Peterson Apr. 1991 25 p
(Contract DE-AC06-76RL-01830)
(DE91-010567; PNL-7670) Avail: NTIS HC/MF A03

The preliminary design concept is presented for the integrated computing and information system to be included in the Environmental and Molecular Sciences Laboratory (EMSL) at the Pacific Northwest Laboratory, Richland, Washington, for the U.S. Department of Energy (DOE). The EMSL is scheduled for completion and occupancy in 1994 or 1995 and will support the DOE environmental mission, in particular hazardous waste remediation. The focus is on the Computing and Information Sciences engineering task of providing a fully integrated state-of-the-art computing environment for simulation, experimentation and analysis in support of molecular research. The EMSL will house two major research organizations, the Molecular Sciences Research Center (MSRC) and part of the Environmental Sciences Research Center (ESRC). Included is a preliminary description of the computing and information system to be included. The proposed system architecture is based on a preliminary understanding of the EMSL users' needs for computational resources. As users understand more about the scientific challenges they face, the definition of the functional requirements will change. At the same time, the engineering team will be gaining experience with new computing technologies. Accordingly, the design architecture must evolve to reflect this new understanding of functional requirements and enabling technologies. DOE

N91-24786# Sandia National Labs., Albuquerque, NM.
PLOTTING AND SUMMARY ROUTINES FOR TASK8
W. F. Chambers and J. H. Doyle Jan. 1991 27 p Prepared in cooperation with EG and G Rocky Flats, Inc., Golden, CO
(Contracts DE-AC04-76DP-00789; DE-AC34-90DP-62349)
(DE91-010689; SAND-90-1701) Avail: NTIS HC/MF A03

Plotting and summary routines available for the TASK8 microprobe operating system are able to accept both spectral and quantitative data. All of the routines are able to be run as subroutines from within the TASK8 program or as stand alone programs. Additionally, the spectral plotting routine can be run from within a modified version of SQ. The quantitative routines currently in use with TASK8. Quantitative output can be sent by the summary program to a serial port that is connected to a VAX or PC in addition to printing it. The plotting codes have been written so that either a Tracor Northern TN2000 or a TN5xxx analyzer may be used with either a Hewlett Packard HP7221 series or a HP7470/HP7550 series plotter. The plotting routine for spectra incorporates a user defineable usual was option to simplify most input procedures. The quantitative plotting routine offers numerous

options including scale expansion, smoothing, auto-labeling, special symbols, and multiple pens. DOE

N91-24787*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE DEVELOPMENT OF A POST-TEST DIAGNOSTIC SYSTEM FOR ROCKET ENGINES
June F. Zakrajsek 1991 13 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; cosponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104463; E-6304; NAS 1.15:104463; AIAA-91-2528)
Avail: NTIS HC/MF A03 CSCL 09B

An effort was undertaken by NASA to develop an automated post-test, post-flight diagnostic system for rocket engines. The automated system is designed to be generic and to automate the rocket engine data review process. A modular, distributed architecture with a generic software core was chosen to meet the design requirements. The diagnostic system is initially being applied to the Space Shuttle Main Engine data review process. The system modules currently under development are the session/message manager, and portions of the applications section, the component analysis section, and the intelligent knowledge server. An overview is presented of a rocket engine data review process, the design requirements and guidelines, the architecture and modules, and the projected benefits of the automated diagnostic system. Author

N91-24788*# Old Dominion Univ., Norfolk, VA. Dept. of Electrical and Computer Engineering
ATAMM ENHANCEMENT AND MULTIPROCESSOR PERFORMANCE EVALUATION Annual Report, 16 Mar. 1989 - 31 Dec. 1990
John W. Stoughton, Roland R. Mielke, Sukhamoy Som, Rodrigo Obando, Mahyar R. Malekpour, Robert L. Jones, III, and Brij Mohan V. Mandala Jun. 1991 111 p
(Contract NCC1-136)
(NASA-CR-188495; NAS 1.26:188495) Avail: NTIS HC/MF A06 CSCL 09B

ATAMM (Algorithm To Architecture Mapping Model) enhancement and multiprocessor performance evaluation is discussed. The following topics are included: the ATAMM model; ATAMM enhancement; ADM (Advanced Development Model) implementation of ATAMM; and ATAMM support tools. Author

N91-24789*# Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
THE EFFECT OF CODE EXPANDING OPTIMIZATIONS ON INSTRUCTION CACHE DESIGN
William Y. Chen, Pohua P. Chang, Thomas M. Conte, and Wen-mei W. Hwu May 1991 38 p
(Contract NAG1-613; N00014-91-J-1283; NSF MIP-88-09478)
(NASA-CR-188467; NAS 1.26:188467; UILU-ENG-91-2227; CRHC-91-17) Avail: NTIS HC/MF A03 CSCL 09B

It is shown that code expanding optimizations have strong and non-intuitive implications on instruction cache design. Three types of code expanding optimizations are studied: instruction placement, function inline expansion, and superscalar optimizations. Overall, instruction placement reduces the miss ratio of small caches. Function inline expansion improves the performance for small cache sizes, but degrades the performance of medium caches. Superscalar optimizations increases the cache size required for a given miss ratio. On the other hand, they also increase the sequentiality of instruction access so that a simple load-forward scheme effectively cancels the negative effects. Overall, it is shown that with load forwarding, the three types of code expanding optimizations jointly improve the performance of small caches and have little effect on large caches. Author

N91-24790*# University of Southern California, Redondo Beach. Behavioral Technology Labs.
INSTRUCTIONAL AUTHORING BY DIRECT MANIPULATION OF SIMULATIONS: EXPLORATORY APPLICATIONS OF RAPIDS. RAPIDS 2 AUTHORING MANUAL Final Technical Report
Aug. 1990 235 p Prepared for Houston Univ., Clear Lake, TX
(Contracts NCC9-16; N00014-85-C-0040; N00014-86-K-0793; N00014-87-C-0489)
(NASA-CR-188591; NAS 1.26:188591) Avail: NTIS HC/MF A11 CSCL 09B

RAPIDS II is a simulation-based intelligent tutoring system environment. It is a system for producing computer-based training courses that are built on the foundation of graphical simulations. RAPIDS II simulations can be animated and they can have continuously updating elements. Author

N91-24791*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
INTELLIGENT TUTORING SYSTEMS FOR SYSTEMS ENGINEERING METHODOLOGIES
Richard J. Meyer, Joel Toland, and Louis Decker (Texas A&M Univ., College Station.) Jan. 1991 113 p
(Contract NCC9-16)
(NASA-CR-188586; NAS 1.26:188586) Avail: NTIS HC/MF A06 CSCL 09B

The general goal is to provide the technology required to build systems that can provide intelligent tutoring in IDEF (Integrated Computer Aided Manufacturing Definition Method) modeling. The following subject areas are covered: intelligent tutoring systems for systems analysis methodologies; IDEF tutor architecture and components; developing cognitive skills for IDEF modeling; experimental software; and PC based prototype. Author

N91-24291# Science Applications International Corp., Fort Washington, PA. Fluid Sciences Div.
ADVANCED COMPUTATIONAL MODELS FOR ANALYZING HIGH SPEED PROPULSIVE FLOWFIELDS
Sanford M. Dash *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 Oct. 1990 p 247-283 (For primary document see N91-24273 16-20)
Avail: NTIS HC/MF A20

N91-24639# Rolls-Royce Ltd., Derby (England).
A ROLE MODEL FOR QUALITY MANAGEMENT IN FINITE ELEMENT ANALYSIS
John Barlow *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 12 p (For primary document see N91-24638 16-39)
Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-24640# Aerospatiale, Toulouse (France). Structural Research and Development Dept.
VALIDATION OF IN-HOUSE AND EXTERNAL SOFTWARE SYSTEMS AT AEROSPATIALE
J. Locatelli and J. C. Sourisseau *In* AGARD, Analytical Qualification of Aircraft Structures Apr. 1991 3 p (For primary document see N91-24638 16-39)
Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

N91-24792*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
NETWORK INTERFACE UNIT DESIGN OPTIONS PERFORMANCE ANALYSIS
Frank W. Miller Jun. 1991 23 p

(NASA-TM-104735; S-635; NAS 1.15:104735) Avail: NTIS HC/MF A03 CSCL 09B

An analysis is presented of three design options for the Space Station Freedom (SSF) onboard Data Management System (DMS) Network Interface Unit (NIU). The NIU provides the interface from the Fiber Distributed Data Interface (FDDI) local area network (LAN) to the DMS processing elements. The FDDI LAN provides the primary means for command and control and low and medium rate telemetry data transfers on board the SSF. The results of this analysis provide the basis for the implementation of the NIU. Author

N91-24793*# Sterling Federal Systems, Inc., Palo Alto, CA.
MODELLING PARALLEL PROGRAMS AND MULTIPROCESSOR ARCHITECTURES WITH AXE
Jerry C. Yan and Charles E. Fineman May 1991 40 p
(Contract NAS2-13210)
(NASA-CR-177582; A-91135; NAS 1.26:177582) Avail: NTIS HC/MF A03 CSCL 09B

AXE, An Experimental Environment for Parallel Systems, was designed to model and simulate for parallel systems at the process level. It provides an integrated environment for specifying computation models, multiprocessor architectures, data collection, and performance visualization. AXE is being used at NASA-Ames for developing resource management strategies, parallel problem formulation, multiprocessor architectures, and operating system issues related to the High Performance Computing and Communications Program. AXE's simple, structured user-interface enables the user to model parallel programs and machines precisely and efficiently. Its quick turn-around time keeps the user interested and productive. AXE models multicomputers. The user may easily modify various architectural parameters including the number of sites, connection topologies, and overhead for operating system activities. Parallel computations in AXE are represented as collections of autonomous computing objects known as players. Their use and behavior is described. Performance data of the multiprocessor model can be observed on a color screen. These include CPU and message routing bottlenecks, and the dynamic status of the software. Author

N91-24794# University of Southern California, Los Angeles. Inst. for Robotics and Intelligent Systems.
IMAGE UNDERSTANDING RESEARCH Final Technical Report, Jun. 1989 - Sep. 1990
Ram Nevatia Feb. 1991 110 p
(Contract F33615-87-C-1436)
(AD-A232995; WL-TR-91-1014) Avail: NTIS HC/MF A06 CSCL 08/2

This report summarizes the USC Image Understanding research projects for the period of June, 1989 to September 1990 on Contract F33615-87-C-1436. Along with our previous annual reports (USCIRIS 238 and 258), it also constitutes our final report for the project. This report consists of a summary section, followed by a number of detailed technical papers. These papers have already been published in conference or workshop proceedings; to save time and effort, we have reproduced these papers in the final document as they originally appeared. The work in these detailed papers and in the previous reports is covered only briefly in this summary. Our research activity under this contract has focussed on the topics of 3-D vision, mapping from aerial images, and parallel processing. Author (GRA)

N91-24795*# Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
TCP PACKET TRACE ANALYSIS M.S. Thesis
Timothy J. Shepard Feb. 1991 73 p
(Grant NAG2-582)
(NASA-CR-188617; NAS 1.26:188617; AD-A233472; MIT/LCS/TR-494) Avail: NTIS HC/MF A04 CSCL 09/2

Examination of a trace of packets collected from the network is often the only method available for diagnosing protocol performance problems in computer networks. This thesis explores the use of packet traces to diagnose performance problems of the transport protocol TCP. Unfortunately, manual examination of these traces can be so tedious that effective analysis is not possible. The primary contribution of this thesis is a graphical method of displaying the packet trace which greatly reduce, the tediousness of examining a packet trace. The graphical method is demonstrated by the examination of some packet traces of typical TCP connections. The performance of two different implementations of TCP sending data across a particular network path is compared. Traces many thousands of packets long are used to demonstrate how effectively the graphical method simplifies examination of long complicated traces. In the comparison of the two TCP implementations, the burstiness of the TCP transmitter appeared to be related to the achieved throughput. A method of quantifying this burstiness is presented and its possible relevance to understanding the performance of TCP is discussed. GRA

N91-24796*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ENHANCING AEROPROPULSION RESEARCH WITH HIGH-SPEED INTERACTIVE COMPUTING
John R. Szuch, Dale J. Arpasi, and Anthony J. Strazisar 1991 18 p Presented at the 10th International Symposium on Air Breathing Engines, Nottingham, England, 1-6 Sep. 1991; sponsored by AIAA
(NASA-TM-104374; E-6179; NAS 1.15:104374) Avail: NTIS HC/MF A03 CSCL 09B

NASA-Lewis has committed to a long range goal of creating a numerical test cell for aeropropulsion research and development. Efforts are underway to develop a first generation Numerical Propulsion System Simulation (NPSS). The NPSS will provide a unique capability to numerically simulate advanced propulsion systems from nose to tail. Two essential ingredients to the NPSS are: (1) experimentally validated Computational Fluid Dynamics (CFD) codes; and (2) high performing computing systems (hardware and software) that will permit those codes to be used efficiently. To this end, NASA-Lewis is using high speed, interactive computing as a means for achieving Integrated CFD and Experiments (ICE). The development is described of a prototype ICE system for multistage compressor flow physics research. Author

63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

N91-24797 Sheffield Univ. (England).
ADAPTIVE CONTROL USING VARIABLE STRUCTURE SYSTEMS Ph.D. Thesis
Omar Mohammad El-Bas El-Ghezawi 1982 184 p
Avail: Univ. Microfilms Order No. BRDX91122

There are numerous approaches to the design of model reference adaptive control systems (MRAC). The theory of variable structure systems (VSS) is studied and applied in the design of MRAC systems. VSS are inherently nonlinear feedback systems which exhibit certain adaptive properties including insensitivity to a range of parameter variations and certain external disturbances when operating in the sliding model. The application of VSS theory to the problem of adaptive model following has demonstrated the simplicity of the design. It also ensures the asymptotic stability of the controlled system and provides direct control over the error transient. The notion of system zeros arises naturally when tackling the problem of output model following control systems. Certain interrelations between VSS, system zeros, and the output model following problem have suggested a new method for computing the zeros of linear multivariable square systems. A fundamental operator in VSS is shown to be a projector. The use of projector theory in the study of VSS provides further insight into their operation. The linear control ensuring output model following and the necessary order reduction is shown to be identical to the equivalent control in VSS. Dissert. Abstr.

N91-24798 Carnegie-Mellon Univ., Pittsburgh, PA.
MAXIMIZATION OF MUTUAL INFORMATION IN A CONTEXT SENSITIVE NEURAL NETWORK Ph.D. Thesis
Gordon James Goetsch 1990 205 p
Avail: Univ. Microfilms Order No. DA9107560

A study is described of a new neural network architecture, CONSENSUS-MMI, that maximizes an information theoretic measure of its performance with a restriction on the amount of communication among the units. The limitation on the bandwidth of communications between the units is a large restriction, one that is inspired by the limits imposed by biology, and is relevant to the potential implementation of neural networks with VLSI technology. The network operates within the classification paradigm; being required to learn to classify a set of input vectors comprising the task domain as indicated by a supervised training signal. The objective function maximized is the mutual information measure which encourages the network to maximize the information conveyed about the correct classification by its classification scheme. It is straightforward to use a single unit that maximizes the mutual information measure, but much more difficult to make a collection of units work beneficially together. The performance of the system was shown by applying it to several domains, including text-to-speech, predicting secondary protein structure from amino acid sequences, and solving chess endgames.
Dissert. Abstr.

N91-24799 Texas Univ., Austin.
STOCHASTIC ADAPTIVE CONTROL FOR A CLASS OF DUAL CONTROL PROBLEMS Ph.D. Thesis
Yungsun Hahn 1990 202 p
Avail: Univ. Microfilms Order No. DA9105562

The stochastic optimal control of systems with uncertain parameters calls for the concept of dual control. The majority of adaptive schemes developed to date rely on the certainty equivalence adaptive controller principle that avoids the difficulties associated with dual control. And studies on approximate dual control techniques have resulted in complex schemes that are not readily implemented. A new stochastic adaptive control structure is developed for a class of dual control problems. The stochastic optimal control solution to the Linear Quadratic Gaussian problem with partial information is considered where the system parameters are assumed to be unknown Gaussian random processes and enter the system equations in such a way that the conditional density is Gaussian. After presenting the main results based on the stochastic optimal control approach, the study concludes with the formulation of a different approach to dual control where the problem is converted into a deterministic one by maximizing with respect to the uncertainties. Some complex features of this problem are identified for future research.
Dissert. Abstr.

N91-24800 Texas A&M Univ., College Station.
OPTIMIZATION OF SYMMETRIC OUTPUT FEEDBACK CONTROL FOR LARGE FLEXIBLE STRUCTURES Ph.D. Thesis
Youdan Kim 1990 156 p
Avail: Univ. Microfilms Order No. DA9106949

A new methodology to optimize globally stable output feedback controllers for mechanical second order systems is developed. First, a new measure of controllability for linear time invariant dynamical system is developed. Qualitatively, this new measure represents a measure of output controllability which reflects both modal controllability and the modal participation of all modes in the physically important cost function. Next, a new methodology to optimize globally stable output feedback controllers for mechanical second order systems is developed. For theoretical background, a few analytical issues involved in symmetric output feedback controller design are discussed, including stability analysis, stability robustness analysis, and a relationship to Linear Quadratic Regulator design. To support the practical value of the ideas presented, numerical examples are considered in two sets: (1) using a 21 degree of freedom model of a planar rotational vibrational flexible structure consisting of a rigid hub with 4 cantilevered flexible appendages, and (2) using a 60 degree of freedom model of a grid structure. The proposed symmetric output feedback design method is successfully implemented and tested for both sets of examples.
Dissert. Abstr.

N91-24801 Clemson Univ., SC.
COMPUTER STEREO VISION FOR 3-D OBJECT LOCATION USING A NEURAL NETWORK ARCHITECTURE Ph.D. Thesis
Madjid Sam Mousavi 1990 197 p
Avail: Univ. Microfilms Order No. DA9107676

In computer vision, it is important for the sensory system to passively sense the three dimensional structure of its surrounding environment. A common method for performing this sensing is through disparity analysis of two images using stereo vision. However, the difficult problem in using disparity is to determine the correspondence of features between two images. Once the correspondences between the two images are known, the depth information of the objects in the scene can be obtained. The correspondence problem is formulated as a constraint satisfaction problem by imposing some relational constraints. Feature extraction and constraint satisfaction are accomplished using a neural network. First, features required in the matching problem are extracted in the low level processing of the images. The process of edge detection is performed by a filter which is implemented in two stages by a network of neurons. The filtering is basically a bottom-up, one-to-one input-output mapping process with a network structure which is time-invariant. The image is applied to the input of a network layer whose receptive fields are edge detection kernels or templates. The strengths of the receptive fields are adjusted to the values of the convolved templates. Once the candidate edges were selected, a multilayered connectionist network is used to extract the features or primitives for matching. A similarity measure is defined and computed for each pair of primitive matches and is passed on to the second stage of the algorithm. The purpose of the second stage is to turn the difficult correspondence problem into a constraint satisfaction problem. Once the process of matching is completed, the disparity can be calculated; then the information about camera calibration parameters can be used to find the three-dimensional location of object points.
Dissert. Abstr.

N91-24802 Ohio State Univ., Columbus.
CONTROL STRATEGIES OF ROBOTIC AND NEUROMUSCULAR BIPEDS Ph.D. Thesis
Hoo Dennis Ong 1990 181 p
Avail: Univ. Microfilms Order No. DA9105178

The Newton-Euler state space formulation is employed to derive the equations of motion for a six link biped. This method provides flexibility since constraint forces can be included in the dynamic equations or eliminated by projection. Muscular actuators are also developed based on the geometry of the muscles. The constraint forces are also modeled as hard constraint forces and soft constraint forces, as different environments warrant different kinds of constraint forces. A controller is developed for the biped based on the Lyapunov's method to control both the neuromuscular and robotic bipeds in the sitting down motion. Digital computer simulations are carried out to verify the effectiveness of the controller. The motion of cycling is investigated to study the co-activation of quadriceps and hamstrings muscles. Two optimizing criteria are proposed. The lying down motion is carried out in the gait laboratory.
Dissert. Abstr.

N91-24803 Texas A&M Univ., College Station.
OPTIMAL CONTROL OF A CLASS OF NONLINEAR DISTRIBUTED PARAMETER SYSTEMS Ph.D. Thesis
Tian-Shen Tang 1990 193 p
Avail: Univ. Microfilms Order No. DA9107000

The objective is to develop an optimal control theory and to formulate a practical design method for a class of systems described by nonlinear partial differential equations (PDE) with a general cost functional. System analysis and control design are performed based on the complete PDE model. The resulting infinite dimensional optimal control is used as a reference to facilitate implementable finite dimension control. Toward the practical

applications, a new definition of admissible control is introduced, an integral version of maximum principle is derived, using dynamic programming and Sobolev space Frechet differential theory, and the costate equation is presented in a general tensor notation. As special cases, the optimal control and optimal state estimation problems for quantum mechanical systems were studied. The optimal regulation problem was studied for a two dimensional hyperbolic system. A general structure for the feedback control was found. It was shown that the linear component (in terms of system state) of the optimal feedback control is equal to the solution of the LQ problem for the linearized system. A target approximation method was developed to facilitate a low dimension controller. This method uses a robust infinite dimensional closed-loop system as a reference. It designs a feedback controller and the actuator and sensor locations in such a way that the resulting feedback system initiates the target so that the closed-loop stability and design performance are preserved. A nonlinear string vibration suppression problem was studied in detail. All the control design techniques developed are demonstrated on this example. Dissert. Abstr.

N91-24804# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.

INTELLIGENT SCHEDULING WITH MACHINE LEARNING CAPABILITIES: THE INDUCTION OF SCHEDULING KNOWLEDGE

Michael J. Shaw, Shang C. Park, and Narayan Raman Nov. 1990 38 p

(AD-A232943; CMU-RI-TR-90-25) Avail: NTIS HC/MF A03 CSCL 12/9

Dynamic scheduling of manufacturing systems has primarily involved the use of dispatching rules. In the context of conventional job shops, the relative performance of these rules has been found to depend upon the system attributes and no single rule is dominant across all possible scenarios. This indicates the need for developing a scheduling approach which adopts a state-dependent dispatching rule selection policy. The importance of adapting the dispatching rule employed to the current state of the system is even more critical in a flexible manufacturing system because of alternative machine routing possibilities and the need for increased coordination among various machines. This study develops a framework for incorporating machine learning capabilities in intelligent scheduling. A pattern-directed method, with a built-in inductive learning module, is developed for heuristic acquisition and refinement. This method enables the scheduler to classify distinct manufacturing patterns and to generate a decision tree consisting of heuristic policies for dynamically selecting the dispatching rule appropriate for a given set of system attributes. Computational experience indicates that the learning-augmented approach leads to improved system performance. In addition, the process of generating the decision tree shows the efficacy of inductive learning in extracting and ranking the various system attributes relevant for deciding upon the appropriate dispatching rule to employ. GRA

N91-24805# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.

PATH GENERATION FOR ROBOT VEHICLES USING COMPOSITE CLOTHOID SEGMENTS

Dong H. Shin and Sanjiv Singh Dec. 1990 35 p

(AD-A232947; CMU-TR-90-31) Avail: NTIS HC/MF A03 CSCL 17/7

The response of an autonomous vehicle in tracking a reference path depends partly on the nature of the path. The condition for paths that are intrinsically amenable to follow are briefly presented, and then a method for the generation of amenable paths is proposed in this paper. Previous path generation methods have sought to simplify a path by using arcs, superarcs, polynomial curves, and clothoid curves to round corners, which result from poly-line fits through a given sequence of points. The developed method consists of two steps: First, a sequence of postures is obtained using given points, then each pair of neighboring postures is connected with three clothoid curve segments. In the second step, a completely general method to connect a path of clothoid curves between two completely arbitrary postures was not envisioned and method for a pair of adjacent postures was developed. By virtue of the property of clothoid curves, a generated path is continuous with respect to position, tangent direction, and curvature, and is linear in curvature. Aside from the properties innate to clothoid curves, the generated paths transition smoothly into turns, pass through all the way points, and sweep outside the corners. For interpolating around obstacles that are commonly inside the corner, these properties are especially useful. GRA

N91-24806# Texas Univ., Austin. Dept. of Electrical and Computer Engineering.

ADAPTIVE CONTROL OF NONLINEAR AND STOCHASTIC SYSTEMS Final Report, 15 Nov. 1985 - 14 Nov. 1990

Steven I. Marcus and Aristotle Arapostathis 14 Jan. 1991 18 p

(Grant AF-AFOSR-0029-86; AF Proj. 2304)

(AD-A232996; AFOSR-91-0175TR) Avail: NTIS HC/MF A03 CSCL 12/4

Significant progress was made in a number of aspects of nonlinear and stochastic systems. An important problem in the adaptive estimation of a finite state Markov chain was solved, and significant progress was made on the corresponding, but much more difficult adaptive control problem. Problems of adaptive control with unknown disturbance distributions were solved in the case of incomplete state observations. A study of the adaptive control of bilinear ARMAX models was completed. Discretization procedures for adaptive Markov control processes were designed and analyzed, and problems of adaptive control with unknown disturbance distributions were solved in the case of incomplete state observations. In the area of nonlinear systems, the effect of sampling of linearization for continuous time systems was investigated. The smooth feedback stabilization of nonlinear systems was studied, and a model reference adaptive control scheme for pure-feedback nonlinear systems was developed and studied, and some problems in the linearization of discrete-time nonlinear systems were solved. In addition, some important problems in the areas of discrete event systems, robotics, and discrete time systems were solved. GRA

N91-24807# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.

REAL-TIME VISION FOR ROBOT SWAT-JUGGLING

Sanjiv Singh 10 Dec. 1990 24 p

(AD-A233010; CMU-RI-TR-90-27) Avail: NTIS HC/MF A03 CSCL 12/9

This paper describes the implementation of a vision system developed to track moving objects in real-time. In the implementation described, a puck sliding on an inclined plane is tracked so that its position and velocity may be used to swat-juggle it to a constant height at a specified lateral position. Raw centroid calculations of the puck based on images from a CCD camera are filtered using an augmented linear observer and an interpolator to produce puck state estimates. Experimental data and results are presented and compared to the previous method of puck state sensing. GRA

N91-24808# Drexel Univ., Philadelphia, PA. Dept. of Electrical and Computer Engineering.

HIERARCHICAL NEURAL NETWORK (HNN) FOR CLOSED LOOP DECISION MAKING: DESIGNING THE ARCHITECTURE OF A HIERARCHICAL NEURAL NETWORK TO MODEL ATTENTION, LEARNING AND GOAL ORIENTED BEHAVIOR Final Report, 1 Nov. 1988 - 31 Oct. 1990

Allon Guez 1 Dec. 1990 276 p

(Grant AF-AFOSR-0010-89; AF Proj. 2305)

(AD-A233030; AFOSR-91-0136TR) Avail: NTIS HC/MF A13 CSCL 12/7

The objectives of the project were to design and evaluate a hierarchical neural network (HNN) capable of real time learning and decision making in closed loop. In the initial stages of the project the problem was defined and the relating state of the art

methods were surveyed. Later control of a robotic system was used as the prototypical task and a HNN was designed and compared with the state of the art adaptive control techniques. During this project the concept of exploratory schedules (ES) was developed. ES is defined as system trajectories internally generated by the HNN for the purpose of efficient learning. This concept was implemented in an open loop fashion for the control of robotic manipulators. A theorem was proved that gives constructive conditions for stable learning in closed loop. Third technique yielded improved transients in tracking desired trajectories in comparison with adaptive control methods. HNN architecture was applied as a controller for a class of nonlinear systems linear in control. It was shown to have guaranteed asymptotic stability. HNN architecture was employed with partial success in areas of pattern recognition and control. GRA

N91-24809# Naval Ocean Systems Center, San Diego, CA.
MODELING THE ENVIRONMENT OF A MOBILE SECURITY ROBOT Interim Report, Sep. 1989 - Jun. 1990
H. R. Everett, G. A. Gilbreath, T. Tran, and J. M. Nieusma Jun. 1990 170 p
(AD-A233074; NOSC/TD-1835) Avail: NTIS HC/MF A08 CSCL 12/9

ROBART 2 is a battery powered autonomous robot used by the Naval Ocean Systems Center (NOSC) as a testbed in research which seeks to provide a multisensor detection, verification, and intelligent assessment capability for a mobile security robot. The intent is to produce a robust automated system exhibiting a high probability of detection, with the ability to distinguish between actual and nuisance alarms, and capable of operation within areas already protected by fixed installation motion detection sensors. An architecture of 13 distributed microprocessors onboard the robot makes possible advanced control strategies and realtime data acquisition. Higher-level tasks (map generation, path planning, position estimation, obstacle avoidance, and statistical security assessment) are addressed by a planner (currently a remote 80386-based desktop computer). Numerous sensors are incorporated into the system to yield appropriate information for use in position estimation, collision avoidance, navigational planning, and assessing terrain traversibility. GRA

N91-24810# California Univ., Los Angeles. Center for the Study of Evaluation.
ARTIFICIAL INTELLIGENCE MEASUREMENT SYSTEM, OVERVIEW AND LESSONS LEARNED Final Report, 1 Jul. 1986 - 28 Feb. 1991
Eva L. Baker and Frances A. Butler Feb. 1991 30 p
(Contract N00014-86-K-0395)
(AD-A233253) Avail: NTIS HC/MF A03 CSCL 12/9

This final report summarizes the work conducted for the Artificial Intelligence Measurement System (AIMS) Project which was undertaken as an exploration of methodology to consider how the effects of artificial intelligence systems could be compared to human performance. The research covered four primary areas of inquiry - natural language understanding, expert systems, machine vision, technology assessment. The four areas are discussed in turn with information provided regarding the goals of individual research efforts within each area. A list of project reports is included in the document. GRA

N91-24811# Defence Research Establishment Suffield, Ralston (Alberta).
A TECHNIQUE FOR OPTIMIZING A NEURAL NETWORK Memorandum Report
Simon A. Barton Dec. 1990 35 p
(AD-A233395; DRES-SM-1351) Avail: NTIS HC/MF A03 CSCL 12/4

This report describes a matrix-based method for optimizing the parameters in a neural network. With this technique, the optimum set of weights and biases is found for the output side of the network with a single hidden layer of neurons, given any set of weights and biases for the input side of the hidden layer. All the input patterns are included in a single calculation cycle. A simple numerical minimization procedure is used to iteratively optimize the weights and biases on the input side of the hidden layer. Several test problems, using both continuous and binary inputs, have been solved, confirming the validity of this matrix optimization technique. In all of the applications tested, the matrix technique optimized networks much more rapidly than the backpropagation method. The results also suggest that while a single-layer network of sigmoidal nodes may in principle be a universal approximator, in practice the maximum accuracy of a functional representation is reduced as the nonlinearity of the function increases. The matrix optimization method is capable of rapidly generating networks that can solve problems similar to those expected in the control of dynamic systems. Based on the work, it should be possible to use the matrix optimization method to define neural networks that can generate the control signals of an autopilot. GRA

N91-24812# California Univ., Los Angeles. Center for the Study of Evaluation.
THE EVALUATION OF EXPERT SYSTEM SHELLS Research Report, 1 Sep. 1986 - 31 Jan. 1991
John R. Novak, Eva L. Baker, and Dean A. Slawson Jan. 1991 38 p
(Contract N00014-86-K-0395)
(AD-A233496) Avail: NTIS HC/MF A03 CSCL 12/5

This paper documents efforts to implement the Artificial Intelligence Measurement System (AIMS) model for expert system shells. The report explains the strategy, provides a review of the literature, and summarizes efforts of a case study of knowledge engineering, first using M-1 and then NEXPERT. The problem domain selected was intended to be a well-structured problem, the selection of an appropriate reliability index for criterion reference tests. GRA

N91-24813# Texas Technological Univ., Lubbock. Optical Systems Lab.
PROGRAMMABLE OPTICAL QUADRATIC NEURAL NETWORKS Final Technical Report, 1 Dec. 1987 - 30 Nov. 1990
John F. Walkup and Thomas F. Krile Jan. 1991 27 p
(Grant AF-AFOSR-0064-88; AF Proj. 2305)
(AD-A233520; AFOSR-91-0201TR) Avail: NTIS HC/MF A03 CSCL 12/7

Analytical and experimental investigations of optical quadratic neural networks have been conducted. Results reported include: (1) Development of a polarization-based outer product processor implementing a quadratic neural network, (2) implementation of a photorefractive crystal based quadratic neural network utilizing feedback for learning, (3) derivation of a statistical parameter which can be used to completely characterize the behavior of linear and higher order Hopfield associative memories and (4) development of a method to reduce the number of interconnections in associative memories while retaining good performance. GRA

N91-24814# Air Force Academy, CO.
FEEDBACK CONTROL FORMULATIONS FOR A COMPLEX FLEXIBLE STRUCTURE UTILIZING REACTION MASS ACTUATORS
Ephrahim Garcia, Brett J. Pokines, Robert A. Carlin, and Steven Webb 1991 6 p
(Contract F49620-88-C-0053)
(AD-A233636; FJSRL-JR-91-0003) Avail: NTIS HC/MF A02 CSCL 13/9

Active control was performed on a structure possessing complex modal behavior. This structure had closely spaced modes, creating a 'beat phenomena' in the structure's free vibration. The dynamic characteristics of the actuators are reported and a model for the interaction of actuator and structure is developed. Reaction mass actuators (RMA's) were analyzed with two control schemes. A local velocity feedback (LVF) controller was designed and implemented. A full state feedback controller was designed and evaluated on an experimentally verified analytical model of the flexible structure. Various linear quadratic regulator (LQR) control

laws were considered and compared to the LVF controller. An investigation was performed using the LQR controller that investigated the effects of the stroke length with a full state feedback controller. GRA

N91-24815*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SENSOR FAILURE DETECTION AND RECOVERY BY NEURAL NETWORKS
Ten-Huei Guo and J. Nurre (Ohio Univ., Athens.) 1991 8 p Presented at the International Joint Conference on Neural Networks, Seattle, WA, 8-12 Jul. 1991; sponsored by the International Neural Network Society and IEEE
(NASA-TM-104484; E-6330; NAS 1.15:104484) Avail: NTIS HC/MF A02 CSCL 09B

A new method of sensor failure detection, isolation, and accommodation is described using a neural network approach. In a propulsion system such as the Space Shuttle Main Engine, the dynamics are usually much higher than the order of the system. This built-in redundancy of the sensors can be utilized to detect and correct sensor failure problems. The goal of the proposed scheme is to train a neural network to identify the sensor whose measurement is not consistent with other sensor outputs. Another neural network is trained to recover the value of critical variables when their measurements fail. Techniques for training the network with a limited amount of data are developed. The proposed scheme is tested using the simulated data of the Space Shuttle Main Engine (SSME) inflight sensor group. Author

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

N91-24816 Israel Inst. of Tech., Haifa. Dept. of Mathematics.
BOUNDARY VALUE PROBLEMS FOR SEMILINEAR ELLIPTIC EQUATIONS M.S. Thesis
Sasha Abramovici Feb. 1987 60 p In HEBREW; ENGLISH summary
(ITN-90-85018) Copyright Avail: Tel-Aviv Univ., Library of Exact Sciences, Ramat Aviv 69978, Israel

Boundary value problems of semilinear elliptic equations in annular and circular domains are examined. The elliptic equations investigated are the sum of two parts: a linear part - the Laplacian, and a non-linear part which is a superlinear function f of the dependent variable. The solution of the above mentioned type of equations, in a ring-like domain in the plane is examined. The following boundary conditions are assumed: (1) The Dirichlet problem in which the solution is zero on the internal circle, and on the external circle; (2) A mixed problem in which the solution is zero on the internal circle while its radial derivative is zero on the external circle; and (3) A mixed problem in which the solution is zero on the external circle while its radial derivative is zero on the internal circle. Interest lies in questions of existence, uniqueness and continuous dependence on the domain of positive, radially symmetric solutions of the three boundary value problems presented above. For the boundary value problem (1) the existence of a positive radially symmetric solution will be proved. Ni and Nussbaum proved that if the radii of the circles are close enough, there exists at most one positive radially symmetric solution. They also proved a theorem concerning the non-uniqueness of the solutions in ring-like domains in the plane and in IR to the power N, N less than or = 3. For the boundary value problem (2) the existence of a positive, radially symmetric solution will be proved. It will be shown that the results of Ni and Nussbaum concerning the uniqueness and non-uniqueness solution of boundary value problem (1) also apply to the boundary value problem (3). Finally, it will be proved that if the equation is the sum of two parts: a linear part - the Laplacian, and a nonlinear part - a product of a super-linear function f of the dependent variable, and a radially symmetric function a, then there exists a positive, radially symmetric solution for the Dirichlet problem on the unit ball in IR to the power N, N less than or = 3. The proof of this fact is based on the variational method of Nehari. ISA

N91-24817*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE L SUB 1 FINITE ELEMENT METHOD FOR PURE CONVECTION PROBLEMS
Bo-Nan Jiang Apr. 1991 28 p Prepared in cooperation with Computational Physics System, Ann Arbor, MI
(NASA Order C-99066-G)
(NASA-TM-103773; E-6039; ICOMP-91-03; NAS 1.15:103773)
Avail: NTIS HC/MF A03 CSCL 12A

The least squares (L sub 2) finite element method is introduced for 2-D steady state pure convection problems with smooth solutions. It is proven that the L sub 2 method has the same stability estimate as the original equation, i.e., the L sub 2 method has better control of the streamline derivative. Numerical convergence rates are given to show that the L sub 2 method is almost optimal. This L sub 2 method was then used as a framework to develop an iteratively reweighted L sub 2 finite element method to obtain a least absolute residual (L sub 1) solution for problems with discontinuous solutions. This L sub 1 finite element method produces a nonoscillatory, nondiffusive and highly accurate numerical solution that has a sharp discontinuity in one element on both coarse and fine meshes. A robust reweighting strategy was also devised to obtain the L sub 1 solution in a few iterations. A number of examples solved by using triangle and bilinear elements are presented. Author

N91-24818*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INSTITUTE FOR COMPUTATIONAL MECHANICS IN PROPULSION (ICOMP) Annual Report No. 5, 1990
Charles E. Feiler, ed. May 1991 51 p
(NASA-TM-103790; ICOMP-91-0; E-6067; NAS 1.15:103790)
Avail: NTIS HC/MF A04 CSCL 12A

The Institute for Computational Mechanics in Propulsion (ICOMP) is operated jointly by Case Western Reserve University and the NASA Lewis Research Center in Cleveland, Ohio. The purpose of ICOMP is to develop techniques to improve problem-solving capabilities in all aspects of computational mechanics related to propulsion. The activities at ICOMP during 1990 are described. Author

N91-24819*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
THE P1-RKDG METHOD FOR TWO-DIMENSIONAL EULER EQUATIONS OF GAS DYNAMICS Final Report
Bernardo Cockburn and Chi-Wang Shu (Brown Univ., Providence, RI.) Mar. 1991 13 p Submitted for publication Sponsored in part by Army High Performance Computing Research Center, Minneapolis, MN and Minnesota Supercomputer Inst., Minneapolis, MN
(Contract NAS1-18605; NSF DMS-88-10150; AF-AFOSR-0093-90; NAG1-1145)
(NASA-CR-187542; NAS 1.26:187542; ICASE-91-32) Avail: NTIS HC/MF A04 CSCL 12A

A class of nonlinearly stable Runge-Kutta local projection discontinuous Galerkin (RKDG) finite element methods for conservation laws is investigated. Two dimensional Euler equations for gas dynamics are solved using P1 elements. The generalization of the local projections, which for scalar nonlinear conservation laws was designed to satisfy a local maximum principle, to systems of conservation laws such as the Euler equations of gas dynamics using local characteristic decompositions is discussed. Numerical examples include the standard regular shock reflection problem, the forward facing step problem, and the double Mach reflection problem. These preliminary numerical examples are chosen to show the capacity of the approach to obtain nonlinearly stable results comparable with the modern nonoscillatory finite difference methods. Author

N91-24820# Grenoble-1 Univ. (France). Lab. de Modelisation et Calcul.
INFIMAL CONVOLUTION EQUATIONS SOLVED USING MOREAU-FENCHEL'S CONJUGATION METHOD [EQUATIONS INF-CONVOLUTIVES ET CONJUGAISONS DE MOREAU-FENCHEL]
Marie-Laurence Mazure and Michel Volle (Avignon Univ., France) Oct. 1990 23 p In FRENCH; ENGLISH summary
(RR-829-M; ETN-91-99230) Avail: NTIS HC/MF A03

A generalized Moreau-Fenchel conjugation that solves equations dealing with infimal convolution and deconvolution is described. One particular vectorial example involving deconvolution of a given function is concentrated on. A method is described that solves situations in which a space X, without additive structures, meets such functions as global Lipschitzian functions that relate r in a metric space X. Each step of the mathematical argument is described in detail and justified. ESA

N91-24821# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Electrical Engineering.
ADVANCED MODELS FOR CLUTTER Interim Report, Jan. 1989 - Feb. 1990
Gary Brown Dec. 1990 40 p
(Contract F19628-89-K-0010)
(AD-A232039; RADC-TR-90-318) Avail: NTIS HC/MF A03
CSCL 17/9

This report summarizes three important results obtained during the reporting period. First, it is shown that the Luneberg-Kline asymptotic series for the current induced on a conducting rough surface always produces an error in the shadow zone. That is, the L-K series yields zero net current in the shadow zone for all terms in the asymptotic series. This shortcoming limits the usefulness of the L-K series for recovering diffraction effects. The method of smoothing is used to determine the fluctuating component of the field scattered by a randomly positioned collection of discrete scatterers to the level of the distorted wave Born approximation. Of particular importance is the role of the coherent or average field in the medium as a source for the fluctuating field. Finally, it is shown how to develop an improved high frequency approximation for scattering from rough surfaces. In particular, it is shown that the shadowed Kirchhoff approximation should comprise the iterate in the basic integral equation for the current because it contains an infinite resummation of all of the shadowing effects. GRA

N91-24822# North Carolina State Univ., Raleigh.
A NUMERICAL AND ANALYTIC ANALYSIS OF NONLINEAR IMPLICIT DIFFERENTIAL EQUATIONS ARISING IN CONTROL AND CIRCUIT PROBLEMS Final Report, 15 Jan. 1987 - 14 Jan. 1991
Stephen L. Campbell 15 Jan. 1991 14 p
(Grant AF-AFOSR-0051-87; AF Proj. 2304)
(AD-A232940; AFOSR-91-0182TR) Avail: NTIS HC/MF A03
CSCL 12/1

Systems of ordinary differential equations are widely used throughout science and engineering to describe varying physical phenomena. Often these differential equations are initially implicit, that is, the highest derivative is not solved for. Traditionally, it has been necessary to first make the equations explicit before the system could be simulated or analyzed. This research is part of the current research effort under way in several disciplines to be able to carry out many parts of design and analysis with these original implicit equations. The ability to do this would not reduce design and analysis time, but also make possible the consideration of more sophisticated models which in turn will provide enhanced system performance. GRA

N91-24823# San Diego State Univ., CA. Center for Research in Mathematics and Science Education.
SCHEMA-BASED THEORIES OF PROBLEM SOLVING Final Report, 1 Nov. 1987 - 31 Dec. 1990
Stephen K. Reed 17 Jan. 1991 35 p
(Grant AF-AFOSR-0107-89; AF Proj. 2313)
(AD-A233003; AFOSR-91-0157TR) Avail: NTIS HC/MF A03
CSCL 12/4

The objective of this project was to formulate a schema-based model of problem solving to represent the construction of equations for solving algebra word problems. The first section shows how this research can be related to five characteristics of schema theories: abstraction of relevant properties, instantiation, and hierarchical organization according to different levels of specificity. The second section discusses the selection of analogous problems to determine whether students are able to judge which of two analogous problems will be more helpful. The third section discusses transfer to similar problems in which subjects must modify a solution to solve a problem that has the same story content. The fourth section discusses transfer to isomorphic problems in which subjects must overcome the different story content to detect the identity of two solutions. The fifth section discusses the variables that influence the successful categorization of problems according to common solution principles. A concluding section compares the schema approach with a research approach that uses general heuristics to find a solution. GRA

N91-24824# Alberta Univ., Edmonton.
THE EXISTENCE OF SMOOTH DENSITIES FOR THE PREDICTION, FILTERING AND SMOOTHING PROBLEMS Final Report, 30 Sep. 1986 - 30 Sep. 1990
Robert J. Elliott 20 Dec. 1990 228 p
(Grant AF-AFOSR-0332-86; AF Proj. 2304)
(AD-A233039; AFOSR-91-0216TR) Avail: NTIS HC/MF A11
CSCL 12/3

Stochastic flows are used to derive martingale representation results and formulae for integration by parts in function space. In turn, these give results on the existence of densities for filtering, smoothing, and prediction problems. Stochastic flows are also used to derive minimum principles in stochastic control, and new equations for the adjoint process. Related results are also obtained for jump processes and the control of Markov chains. Martingale representation results are used to minimize expected risk. Using integration by parts reverse time representations of jump processes are obtained. These results have applications in, for example, smoothing and the Malliavin calculus. GRA

N91-24825# Society for Industrial and Applied Mathematics, Philadelphia, PA.
SIAM CONFERENCE ON DYNAMICAL SYSTEMS Final Technical Report, 1 Apr. 1990 - 31 Mar. 1991
I. E. Block 31 Mar. 1991 5 p Conference held in Orlando, FL, 7-11 May 1990
(Grant AF-AFOSR-0149-90; AF Proj. 2304)
(AD-A233112; AFOSR-91-0154TR) Avail: NTIS HC/MF A01
CSCL 12/4

The SIAM Conference on Dynamical Systems was designed to provide a forum for the continued interdisciplinary development of the modern theory of dynamical systems. The close connections between theory, numerics, and applications has had a revolutionizing effect on the growth of dynamical systems as a field. The conference successfully met its primary goal of drawing members from the dynamical systems community together to discuss recent achievements both in the general geometric theory of dynamical systems, as well as in problem-specific developments. GRA

N91-24826# Alberta Univ., Edmonton.
POINT PROCESSES AND APPROXIMATION Final Report, 15 Jul. 1987 - 14 Nov. 1990
Robert J. Elliott 30 Jan. 1991 6 p
(Contract DAAL03-87-K-0102)
(AD-A233179; ARO-24919.13-MA) Avail: NTIS HC/MF A02
CSCL 12/3

A diffusion is approximated by a Markov chain. By considering multivariate point process observations robust approximate filters are obtained. Two sided filtering results are derived. Filters with small nonlinear terms in the signal process are computed. Error

estimates for approximate solutions of the Zakai equation are obtained. Integration by parts formulae in function space for Poisson and jump processes are derived. New equations for the adjoint process in stochastic control are obtained using martingale representation results. GRA

N91-24827# Nova Univ., Dania, FL. Oceanographic Center.
GENERAL CLOSED-FORM ORTHONORMALIZATION METHODS WITH APPLICATIONS TO ADJUSTMENT TENSORS
Georges Blaha Nov. 1990 90 p
(Contract F19628-89-K-0016)
(AD-A233180; GL-TR-90-0360; SR-1) Avail: NTIS HC/MF A05 CSCL 12/2

The present study designs closed-form orthonormalization methods applicable under different kinds of general conditions. These methods are based on the geometrical concept of a u-dimensional surface embedded in an n-dimensional space, and are developed with the use of tensor structure and notation. An important task, which has several variations, consists in expressing a set of n orthonormal vectors in terms of a set of u less than n oblique unit vectors. The space may in general be endowed with a non-Cartesian metric, and the (associated) metric tensor may or may not be given. The resolution of the orthonormal set accomplishes in a closed form what the Gram-Schmidt orthogonalization process will accomplish via an algorithm if it is extended from u given vectors to n vectors, and if it is applied in a general coordinate system. GRA

N91-24828# Yale Univ., New Haven, CT. Dept. of Computer Science.
ON THE INVERSE SCATTERING PROBLEM FOR THE HELMHOLTZ EQUATION IN ONE DIMENSION
Y. Chen and V. Rokhlin Dec. 1990 64 p
(Contracts N00014-89-J-1527; N00014-89-J-1906)
(AD-A233346; YALEU/DCS/RR-838) Avail: NTIS HC/MF A04 CSCL 12/1

A scheme is presented for the solution of inverse scattering problems for the one dimensional Helmholtz equation. The scheme is based on a combination of the standard Riccati equation for the impedance function with a new trace formula for the derivative of the potential, and can be viewed as a frequency domain version of the layer-stripping approach. GRA

N91-24829# Defence Research Establishment, Ottawa (Ontario).
A RUDIMENTARY OVERVIEW OF THE CAPABILITIES AND PROBLEMS CONCERNING THE FINITE-ELEMENT METHOD
J. J. Klaasen Feb. 1991 16 p IN ENGLISH and FRENCH
(AD-A233431; DREO-1067) Avail: NTIS HC/MF A03 CSCL 12/1

The finite element method is very powerful and flexible to model complex geometries with computers, because the region of interest can be subdivided into finite elements accurately. The advantages and drawbacks of the finite-element method will be the focus of the rudimentary investigation presented in this report. Especially, the requirements in terms of computational effort and computer memory storage will be investigated with respect to Nuclear ElectroMagnetic Pulse (NEMP) research requirements, i.e., with configurations frequently found in NEMP research such as coupling and interaction studies, simulator design and sensor design. Such configurations are often three dimensional and of intricate geometry. It is found that with present day computer capability it is not yet possible to solve real-life three dimensional geometries with the finite-element method, because of the memory requirements needed to store the resulting system of equations. Two dimensional geometries can at present be solved with the finite-element method, but the usefulness of two dimensional geometries for NEMP research purposes is questionable. GRA

N91-24830# Maryland Univ., College Park. Center for Automation Research.
NOISE-RESISTANT INVARIANTS OF CURVES
Isaac Weiss Feb. 1991 27 p
(Contract N00014-91-J-1222)
(AD-A233440; CAR-TR-537; CS-TR-2615) Avail: NTIS HC/MF A03 CSCL 12/9

Invariants of shapes are of major importance in object recognition because they are independent of the point of view from which the shape is seen. However, they require a relatively high number of parameters that need to be extracted from the shape, which raises concerns about the reliability of such descriptors. In this paper, we address the accuracy and reliability issue and show that the method can be made robust to noise. We have found new differential invariants requiring fewer derivatives, and we use smoothing techniques which give much better results than the Gaussian. Our experiments show that the derivatives involved do not pose a serious problem, provided we make the right choice of smoothing method and parameters. GRA

N91-24831# Naval Postgraduate School, Monterey, CA.
BOUNDS ON THE EXTREME GENERALIZED EIGENVALUES OF HERMITIAN PENCILS Technical Report, 1 Jul. - 31 Dec. 1990
Monique P. Fargues 31 Dec. 1990 26 p
(AD-A233517; NPS62-90-016) Avail: NTIS HC/MF A03 CSCL 12/1

We present easily computable bounds on the extreme generalized eigenvalues of Hermitian pencils (R,B) with finite eigenvalues and positive definite B matrices. The bounds are derived in terms of the generalized eigenvalues of the subpencil of maximum dimension contained in (R,B). Known results based on the generalization of the Gershgorin theorem and norm inequalities are presented and compared to the proposed bounds. It is shown that the new bounds compare favorably with these known results; they are easier to compute, require less restrictions on the properties of the pencils studied, and they are in an average sense tighter than those obtained with the norm inequality bounds. GRA

N91-24832# Sandia National Labs., Albuquerque, NM.
BACKWARD ITERATION IN A RATIONAL INTERPOLATION APPLICATION
J. P. Brannen 2 May 1991 7 p Presented at the 22nd Annual Conference on Modeling and Simulation, Pittsburgh, 2-3 May 1991
(Contract DE-AC04-76DP-00789)
(DE91-010865; SAND-91-0873C; CONF-9105165-1) Avail: NTIS HC/MF A02

Rational interpolation is frequently useful for generating functions which have an extended range over an abbreviated domain of definition. A simple technique for continued fraction interpolating function evaluation can easily be modified to obtain the function's derivative. This is a useful technique for developing numerical solutions for certain stiff partial differential equations. DOE

N91-24833*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
SINC-GALERKIN ESTIMATION OF DIFFUSIVITY IN PARABOLIC PROBLEMS Final Report
Ralph C. Smith and Kenneth L. Bowers (Montana State Univ., Bozeman.) May 1991 37 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187567; NAS 1.26:187567; ICASE-91-43) Avail: NTIS HC/MF A03 CSCL 12A

A fully Sinc-Galerkin method for the numerical recovery of spatially varying diffusion coefficients in linear partial differential equations is presented. Because the parameter recovery problems are inherently ill-posed, an output error criterion in conjunction with Tikhonov regularization is used to formulate them as infinite-dimensional minimization problems. The forward problems are discretized with a sinc basis in both the spatial and temporal domains thus yielding an approximate solution which displays an exponential convergence rate and is valid on the infinite time interval. The minimization problems are then solved via a

quasi-Newton/trust region algorithm. The L-curve technique for determining an approximate value of the regularization parameter is briefly discussed, and numerical examples are given which show the applicability of the method both for problems with noise-free data as well as for those whose data contains white noise.
Author

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

N91-24834# Stanford Univ., CA. Dept. of Statistics.
IMPORTANCE SAMPLING FOR TAIL PROBABILITIES
Satish Iyengar 6 Feb. 1991 17 p
(Contract N00014-89-J-1627)
(AD-A232412; TR-440) Avail: NTIS HC/MF A03 CSCL 12/3

Our interest is in the accurate and efficient evaluation of very small probabilities. Thus, we seek methods with bounded coefficient of variation as the probability decreases and we assess their performance. The univariate case is explored for a heuristic for construction of sampling density families. The multivariate case provides interesting connections with Mills' ratio. GRA

N91-24835# Columbia Univ., New York, NY.
STOCHASTIC AND CONTROL AND TOPICS IN APPLIED PROBABILITY Final Report, 1 Aug. 1986 - 31 Oct. 1990
Ioannis Karatzas Feb. 1991 7 p
(Grant AF-AFOSR-0203-86; AF Proj. 2304)
(AD-A233298; AFOSR-91-0211TR) Avail: NTIS HC/MF A02 CSCL 12/3

We review the research, accomplished with the support of the above grant, in the broad areas of Stochastic Control and Applied Probability. Specific topics of interest include Singular Stochastic Control, Optimal Stopping, Transition densities for Diffusion Processes, Path Decompositions, Bayesian Adaptive Control, Brownian Motion and Stochastic Calculus, Stochastic Control under Incomplete Observations. GRA

66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

N91-24836# Grenoble-1 Univ. (France). Lab. Artemis.
CYCLICAL GAMES WITH PROHIBITIONS
Alexander V. Karzanov and Vasilij N. Lebedev (Physical-Technical Inst., Moscow, USSR) Jun. 1990 21 p
(RR-821-M; ETN-91-99227) Avail: NTIS HC/MF A03

Two classes of combinatorial games on a diagraph are considered. One of them generalizes a cyclical game which, in turn, extends the well known problem of finding a minimum mean cycle in a weighted diagraph. The existence of optimal uniform stationary strategies for both classes is demonstrated. Algorithms to be used in finding such strategies are described. ESA

N91-24837# District of Columbia Univ., Washington, DC.
A SUMMER PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE FOR ACADEMICALLY ORIENTED STUDENTS Final Report
Bernis Barnes 27 Jul. 1990 166 p Summer Program held in Washington, DC, 25 Jun. - 27 Jul. 1990
(AD-A233546) Avail: NTIS HC/MF A08 CSCL 05/6

The purpose of this project is to implement an intensive pre-college intervention program for academically talented students, mainly ninth and tenth grade students from the District of Columbia area, that is designed to increase their representation in mathematics-based careers. By offering the program at this grade level, the students are able to take more rigorous math courses while in high school. The goals of the project are (1) to strengthen the students' backgrounds in mathematics, computer science, and statistics and operations research, (2) to improve their academic skills with an emphasis on reasoning competencies, (3) to increase their awareness of careers in mathematics-based fields and of the preparation needed for these fields, and (4) to encourage and motivate these students to enroll in calculus track courses while in high school. GRA

67 THEORETICAL MATHEMATICS

Includes topology and number theory.

No abstracts in this category.

70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

N91-24838# National Inst. of Standards and Technology, Gaithersburg, MD. Center for Chemical Technology.
GUIDELINES FOR REALIZING THE INTERNATIONAL TEMPERATURE SCALE OF 1990 (ITS-90) Final Report
B. W. Mangum and G. T. Furukawa Aug. 1990 193 p
(PB91-112854; NIST/TN-1265) Avail: NTIS HC/MF A09 CSCL 20C

The International Temperature Scale of 1990 (ITS 90) that became the official international temperature scale on 1 January 1990, superseding the previous scales is described and information is provided on how the scale may be realized at different levels of accuracy. The ITS 90 extends upward from 0.65 K, is in close agreement with the Kelvin Thermodynamic Temperature Scale, has much improved continuity, precision and reproducibility throughout its ranges over that of previous scales, and has subranges and alternative definitions in certain ranges that greatly facilitate its use. In addition to a description of the ITS 90 and how it can be realized, there are included reproductions of some articles or excerpts from articles concerned with the ITS 90. The composition of the Comite Consultatif de Thermometrie (CCT) of the Comite International des Poids et Mesures (CIPM) at the time of the adoption of the ITS 90 is given. The differences between the temperatures on the ITS 90 and those on the International Practical Temperature Scale of 1968, and those on the 1976 Provisional 0.5 to 30 K Temperature Scale (EPT 76) are tabulated.
Author

N91-24839# Mardon (Austin Albert), Lethbridge (Alberta).
INTERNATIONAL STANDARDIZATION IN SPACE SYSTEMS
Austin Albert Mardon 1990 48 p
(PB91-135988) Avail: NTIS HC/MF A03 CSCL 20C

The Agreement on the Rescue of Astronauts, the Return of Astronauts, and Objects Launched into Outer Space of 1968 (assistance agreement) is an international treaty that could become a legal testbed for the elaboration, strengthening, and expansion of the space law regime. A revised and expanded assistance agreement could be the result of a proactive stance to introduce standardization of human and machine rescue systems. It could also strengthen general attempts to reduce man made environmental hazards in the outer space environment. GRA

N91-24840# University of Southern California, Los Angeles. Inst. for Robotics and Intelligent Systems.
MOTION ANALYSIS AND ITS APPLICATIONS Final Technical Report, 15 Sep. 1989 - 14 Dec. 1990
Ram Nevatia 31 Dec. 1990 13 p
(Contract F49620-89-C-0126; DARPA Order 6227)
(AD-A232945; AFOSR-91-0187TR) Avail: NTIS HC/MF A03 CSCL 17/11

This research project has addressed motion analysis and its applications with the study of techniques to detect, track, and predict the motion of moving objects from a moving platform. For this project, the major goal was the development of techniques of images from a 3-D environment using a sequence separate research projects in motion analysis, which also used general image analysis techniques from other (past or current) research projects. The overall direction of the motion analysis research is given along with descriptions of major recent results. GRA

N91-24841# Naval Postgraduate School, Monterey, CA.
THE MEANING OF TIME: AN INTRODUCTION INTO PHILOSOPHICAL, BIOLOGICAL AND PHYSICAL ASPECTS OF TIME Technical Report, Jan. - Dec. 1990
Karlheinz E. Woehler 15 Jan. 1991 312 p
(AD-A233001; NPS-PH-91-005) Avail: NTIS HC/MF A14 CSCL 05/6

This report presents an introduction into philosophy, biology astrophysics and other physical sciences as they relate to time. Time in man's basic experience, symbolizations of time, the western view of historical time and the evolution of the concept of time in philosophy are outlined. A brief introduction to biological clocks, chemical oscillations, biochemical cycles, and speculations about the human time sense follow. The major portion of the report deals with the search for the arrow of time in nature from physics. Absolute time in Newtonian physics, time in special relativity and the time inversion invariance of physical laws, appears to leave no room for an arrow of time in nature. Even the concept of entropy and the second law of thermodynamics are found not to be grounded in the laws of nature themselves but rather in the initial conditions of time evolving systems. The search for the origin of the arrow of time leads to the big bang origin of the universe which has a very low entropy state. The proper description of the evolution of the universe in terms of general relativity shows that time cannot be a dimension external to the universe but appears as an internal evolution parameter in recent attempts in the literature to give a cosmological description of the origin of the universe using the quantum theory. GRA

N91-24842# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Metallurgical Engineering and Materials Science.
STUDIES INVOLVING THE SYNTHESIS AND CHARACTERIZATION OF HIGH ENERGY MAGNET MATERIALS Final Report
W. E. Wallace 11 Jan. 1991 17 p
(Contract DAAL03-87-K-0150)
(AD-A233081; ARO-24378.17-MS) Avail: NTIS HC/MF A03 CSCL 20/3

Permanent magnets are essential components of a wide range of modern devices, many of which have military significance: travelling wave tubes, klystrons, linear induction accelerators, high power free electron lasers, high performance motors and generators, etc. Higher energy permanent magnets enable one to downsize the various devices which operate via permanent magnets. The present study had as its main objectives: (1) improving existing high energy magnets, and (2) developing new magnets. The systems studied with this in mind fall into three structural types: those having (1) the Nd2Fe14B structure; (2) the ThMn12 structure; and (3) the Sm2Co17 structure. Results of the studies are presented in 26 papers published in the open literature. Highlights of the work are provided in this report by giving terse summaries of 9 of the papers. The work has been a part of the world-wide effort to make Nd2Fe14B magnets into a commercial reality. GRA

71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

N91-24843# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
AGARD FLIGHT TEST TECHNIQUES SERIES. VOLUME 9: AIRCRAFT EXTERIOR NOISE MEASUREMENT AND ANALYSIS TECHNIQUES
H. Heller (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) Apr. 1991 201 p
(AGARD-AG-300-Vol-9; ISBN-92-835-0612-X) Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Testing and analysis techniques to measure aircraft noise primarily for purposes of noise certification as specified by the 'International Civil Aviation Organization', ICAO are described. The relevant aircraft noise certification standards and recommended practices are presented in detail for subsonic jet aircraft, for heavy and light propeller-driven aircraft, and for helicopters. The practical execution of conducting noise certification tests is treated in depth. The characteristics and requirements of the acoustic and non-acoustic instrumentation for data acquisition and data processing are discussed, as are the procedures to determine the special noise measures - effective perceived noise level (EPNL) and maximum overall A-weighted noise level (L sub pA,max) - that are required for the noise certification of different types of aircraft. The AGARDograph also contains an extensive, although selective, discussion of test and analysis techniques for more detailed aircraft noise studies by means of either flight experiments or full-scale and model-scale wind tunnel experiments. Appendices provide supplementary information. Author

N91-24844*# Lockheed Aeronautical Systems Co., Burbank, CA.
LABORATORY TEST AND ACOUSTIC ANALYSIS OF CABIN TREATMENT FOR PROPFAN TEST ASSESSMENT AIRCRAFT Interim Report
H. L. Kuntz and R. J. Gatineau May 1991 144 p
(Contract NAS1-18036)
(NASA-CR-182075; LR-31879; NAS 1.26:182075) Avail: NTIS HC/MF A07 CSCL 20A

An aircraft cabin acoustic enclosure, built in support of the Propfan Test Assessment (PTA) program, is described. Helmholtz resonators were attached to the cabin trim panels to increase the sidewall transmission loss (TL). Resonators (448) were located between the trim panels and fuselage shell. In addition, 152 resonators were placed between the enclosure and aircraft floors. The 600 resonators were each tuned to a 235 Hz resonance frequency. After flight testing on the PTA aircraft, the enclosure was tested in the Kelly Johnson R and D Center Acoustics Lab. Laboratory noise reduction (NR) test results are discussed. The enclosure was placed in a Gulfstream 2 fuselage section. Broadband (138 dB overall SPL) and tonal (149 dB overall SPL) excitations were used in the lab. Tonal excitation simulated the propfan flight test excitation. The fundamental tone was stepped in 2 Hz intervals from 225 through 245 Hz. The resonators increase the NR of the cabin walls around the resonance frequency of the resonator array. The effects of flanking, sidewall absorption, cabin adsorption, resonator loading of trim panels, and panel vibrations are presented. Increases in NR of up to 11 dB were measured. Author

N91-24845*# Lockheed Engineering and Sciences Co., Hampton, VA.
SIGNAL PROCESSING OF AIRCRAFT FLYOVER NOISE
Jeffrey J. Kelly May 1991 86 p
(Contract NAS1-19000)
(NASA-CR-187546; NAS 1.26:187546) Avail: NTIS HC/MF A05 CSCL 20A

A detailed analysis of signal processing concerns for measuring aircraft flyover noise is presented. Development of a

de-Dopplerization scheme for both corrected time history and spectral data is discussed along with an analysis of motion effects on measured spectra. A computer code was written to implement the de-Dopplerization scheme. Input to the code is the aircraft position data and the pressure time histories. To facilitate ensemble averaging, a uniform level flyover is considered but the code can accept more general flight profiles. The effects of spectral smearing and its removal is discussed. Using data acquired from XV-15 tilt rotor flyover test comparisons are made showing the measured and corrected spectra. Frequency shifts are accurately accounted for by the method. It is shown that correcting for spherical spreading, Doppler amplitude, and frequency can give some idea about source directivity. The analysis indicated that smearing increases with frequency and is more severe on approach than recession. Author

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

N91-24846*# Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy.
SPECTRA, COMPOSITION AND INTERACTIONS OF NUCLEI ABOVE 10 TeV USING MAGNET-INTERFEROMETRIC CHAMBERS (SCIN/MAGIC) Final Report
John P. Wefel 15 Feb. 1991 10 p
(NASA Order H-11204-F)
(NASA-CR-188218; NAS 1.26:188218) Avail: NTIS HC/MF A02 CSCL 20H

Initial definition studies were performed for the SCIN/MAGIC experiment selected as an Astromag investigation on Space Station Freedom. The study focused on Science Objectives and Science Requirement, Accommodation on both the STS and the Astromag facility, Data extraction techniques and Background Studies. The detectors are emulsion chambers which will be exposed for approximately 90 days and then recovered from orbit for subsequent processing and analysis in the laboratory. Such a technique is the only means to obtain information on the ultrahigh energy cosmic rays and their nuclear interactions. The SCIN/MAGIC investigation can supply unique data in relatively unexplored energy region and address many of the fundamental questions in particle astrophysics. Author

N91-24847*# Alabama Univ., Huntsville. Dept. of Physics.
DIFFERENTIAL COLLISION CROSS-SECTIONS FOR ATOMIC OXYGEN Final Technical Progress Report, 11 Jul. 1989 - 10 Jul. 1990
Douglas G. Torr 19 Feb. 1991 138 p
(Contract NAS8-36955)
(NASA-CR-187892; NAS 1.26:187892; OAL91-1) Avail: NTIS HC/MF A07 CSCL 20H

Differential collision cross-sections of O on N2 and other gases were measured to understand vehicle-environmental contamination effects in orbit. The following subject areas are also covered: groundbased scientific observations of rocket releases during NICARE-1; data compression study for the UVI; science priorities for UV imaging in the mid-1990's; and assessment of optimizations possible in UV imaging systems. Author

N91-24848# Quaid-i-Azam Univ., Islamabad (Pakistan). Dept. of Physics.
INTERACTION OF SQUEEZED LIGHT WITH A TWO LEVEL ATOM M.S. Thesis
Muhammad Arif 1990 83 p
(PB91-130112) Avail: NTIS HC/MF A05 CSCL 20H

The effects of cavity detuning and damping on the predictions of the one-photon Jaynes Cummings model about the atomic population inversion and the second-order coherence function are computed. For the cases where both detuning and damping are present, two alternative approximation schemes based on second-order perturbation theory are developed and numerically analyzed. For the case where damping is absent but detuning present, an exact solution of the density matrix is worked out and a numerical study of the dynamical quantities of interest carried out. The three approaches used are compared with one another. Author

N91-24849# New Orleans Univ., LA. Dept. of Chemistry.
COMPUTATIONAL STUDIES OF ENERGETIC STRAINED MOLECULES: PROPERTIES AND SYNTHESES OF TETRAHEDRANE AND TRIPRISMANE SYSTEMS Final Report, 1 Nov. 1987 - 31 Oct. 1990
Peter Politer 19 Dec. 1990 18 p
(Grant AF-AFOSR-0068-88; AF Proj. 2303)
(AD-A232857) Avail: NTIS HC/MF A03 CSCL 07/3

We have carried out ab initio self consistent field computational analyses and evaluations of nitro, amino nitro/amino, and nitro/methyl derivatives of the strained tetrahedrane, triprismane, and their aza analogues. We computed 3-21 G optimized geometries and used them to calculate bond deviation indices (as measures of bond strain), bond orders (to determine relative bond strengths), molecular electrostatic potentials and surface average local ionization energies (as guides to reactive behavior), isodesmic reaction energies (as measures of total molecular strain), and relative stabilities of isomers. Specific impulse calculations showed that aza derivatives are favored over their hydrocarbon analogues as high performance monopropellants. From standpoints of stability, synthesis, and high performance, we recommend that nitro and nitro-amino derivatives of azatetrahedranes and azatriprismanes be further explored as high energy density target systems. GRA

N91-24850# Ballistic Research Labs., Aberdeen Proving Ground, MD.
CLASSICAL DYNAMICS STUDIES OF UNIMOLECULAR DECOMPOSITION OF NITROMETHANE Final Report, Dec. 1988 - Jan. 1990
Betsy M. Rice and Donald L. Thompson Feb. 1991 105 p
(DA Proj. 1L1-61102-AH-43)
(AD-A232867; BRL-TR-3197) Avail: NTIS HC/MF A06 CSCL 19/1

Classical trajectories are used to investigate the unimolecular decomposition of nitromethane on three model potential energy surfaces. The surfaces differ mainly in the barrier height for the isomerization of nitromethane to methyl nitrite (216.4, 55.1, and 47.6 kcal/mol). In addition to the two primary reactions observed by Wodtke, Hintsa, and Lee (1986), a third reaction was observed: CH3NO2 yields CH3ONO yields CH3 + NO2. The dynamic results also show that there are two mechanisms for isomerization of nitromethane to methyl nitrite: (1) a two-step process of dissociation of nitromethane of CH3 + NO2 and subsequent recombination of these radicals to form methyl nitrite, and (2) a one-step process of concerted C-N bond breaking and C-O bond formation. Product energy distributions indicate that the products formed from C-N bond scission in nitromethane and C-O bond scission in methyl nitrite are indistinguishable. GRA

N91-24851# Colorado State Univ., Fort Collins. Dept. of Chemistry.
NORMAL MODE ANALYSIS OF VAN DER WAALS VIBRATIONS
S. Li and E. R. Bernstein 7 Mar. 1991 37 p
(Contract N00014-89-J-1237)
(AD-A232891) Avail: NTIS HC/MF A03 CSCL 07/4

Two algorithms are presented for calculation of the van der Waals modes of weakly bound clusters. Both methods rely on the harmonic normal mode approximation and a chosen intermolecular potential. These calculational techniques differ specifically in the form of the force field employed: one method uses the total (both intra- and inter-molecular) force field for the cluster and the other uses only the intermolecular force field. Both methods require rather elaborate coordinate transformation and their first and second partial derivatives; these are provided in detail. The two calculations generate eigenvalues and eigenvectors that are in complete agreement with one another for a given potential. The

methods insure that the van der Waals modes are calculated at the proper cluster equilibrium configuration for which all torques and forces on molecules and/or atoms are effectively zero. Examples are presented for (H2O)2(n=2, ...,7), benzene clustered with water, methane, and ammonia, and a number of different intermolecular potentials. Some of the observed heterogeneous cluster van der Waals modes are reassigned in light of these new result. Author (GRA)

N91-24852# Massachusetts Inst. of Tech., Cambridge.
VIBRATIONALLY ENERGIZED MOLECULES: UNIMOLECULAR ENERGY FLOW, CHAOS, AND LEVEL SPECIFIC CHEMISTRY Final Report, 1 Nov. 1987 - 31 Oct. 1990
Robert W. Field and Robert J. Silbey 31 Dec. 1990 20 p
(Grant AF-AFOSR-0062-88; AF Proj. 2303)
(AD-A232898; AFOSR-91-0177TR) Avail: NTIS HC/MF A03 CSCL 20/5

The goal has been to develop experimental and theoretical methods capable of characterizing the structure and dynamics of molecules undergoing large amplitude vibrational motions and/or chaotic dynamics. Progress was made toward this goal using the Stimulated Emission Pumping technique combined with statistical pattern-recognition schemes. The SEP study of HCP samples the HCP HPC isomerization barrier. Three statistical pattern recognition techniques - Statistical Fourier Transform, Spectral Cross-Correlation, and Extended Autocorrelation, were developed and applied to experimental and computed spectra of HCN, HCP, acetylene, and NO2. GRA

N91-24853# Oregon Univ., Eugene. Dept. of Chemistry.
ROTATIONAL AND VIBRATIONAL SPECTRA OF MOLECULAR CLUSTERS Final Report, 15 Jun. 1987 - 15 Aug. 1990
Thomas R. Dyke and Joseph W. Nibler 30 Jan. 1991 18 p
(Contract F49620-87-C-0072)
(AD-A232959; AFOSR-91-0057TR) Avail: NTIS HC/MF A03 CSCL 20/5

The principal goal of this research is to understand intermolecular forces through the structure and vibrational properties of small clusters. The intermolecular forces holding these complexes together also largely determine the properties of many important systems such as condensed phases and macromolecules. Clusters involving water are of particular interest in understanding liquid water and ice, aqueous solutions and atmospheric phenomena. Thus this work will help in understanding these systems and the general phenomena of intermolecular forces. GRA

N91-24854# Florida Univ., Gainesville.
WORKSHOP ON COUPLED-CLUSTER THEORY AT THE INTERFACE OF ATOMIC PHYSICS AND QUANTUM CHEMISTRY Final Report, 1 Jul. - 31 Dec. 1990
Rodney J. Bartlett 5 Mar. 1991 17 p Workshop held in Cambridge, MA, 6-11 Aug. 1990
(Grant AF-AFOSR-0298-90; AF Proj. 2301)
(AD-A233141; AFOSR-91-0215TR) Avail: NTIS HC/MF A03 CSCL 20/5

The Workshop on Coupled-Cluster Theory linked researchers by the need for high accuracy correlated calculations for electronic structure in atoms and molecules. One group were experts in coupled-cluster (CC) and many body perturbation methods (MBPT) approaches for electron correlation in molecules, and had developed very powerful tools for determining molecular structure and spectra using CC/MBPT methods. The second group was primarily concerned with important applications to weak interactions in atoms, while employing many body techniques in their calculations. Many examples were shown that demonstrate numerically the inherent superiority of CC methods for electron correlation compared to most other approaches. GRA

N91-24855# Naval Research Lab., Washington, DC.
THEORY OF ELECTRON BEAM TRACKING IN REDUCED-DENSITY CHANNELS Memorandum Report
R. F. Fernsler, S. P. Slinker, and R. F. Hubbard 2 Apr. 1991 51 p Sponsored by NSWC, Silver Spring, MD and DARPA, Arlington, VA
(AD-A233387; NRL-MR-6806) Avail: NTIS HC/MF A04 CSCL 20/7

A theory is presented for the guiding of relativistic electron beams by rarefied gaseous channels. The analysis is based on analytic computations of the transverse force felt by a rigid-rod beam propagating off-axis from a channel or reduced gas density. The density gradients produce an attractive channel force that can be surprisingly robust, even though it develops from relatively subtle gas chemistry properties. Static numerical calculations support the analytic work. Longitudinal beam coupling and effects that degrade channel guidance are discussed as well. GRA

N91-24856# Air Force Academy, CO.
MOPAC MANUAL. SIXTH EDITION. A GENERAL MOLECULAR ORBITAL PACKAGE
James J. Stewart Nov. 1990 208 p
(AF Proj. 2303)
(AD-A233489; FJSRL-TR-90-0004) Avail: NTIS HC/MF A10 CSCL 07/4

MOPAC is a general-purpose, semi-empirical molecular orbital program for the study of chemical reactions involving molecules, ions, and linear polymers. It implements the semi-empirical Hamiltonians MNDO, AM1, PM3, and MINDO/3 and combines the calculations of vibrational spectra, thermodynamic quantities, isotopic substitution effects, time-dependent effects, and force constants in a fully integrated program. Elements parameterized at the PM3 level are H, Be, C, N, O, F, Mg, Al, Si, P, S, Cl, Zn, Ija, Ije, As, Br, Cd, In, Sn, Sb, Te, I, Hg, Tl, Pb, and Bi. Within the electronic part of the calculation, molecular and localized orbitals excited states up to sextets, chemical bond indices, charges, etc. are computed. Both intrinsic and dynamic reaction coordinates can be calculated. A transition-state location routine and two transition-state optimizing routines are available for studying chemical reactions. GRA

N91-24857# Colorado State Univ., Fort Collins. Dept. of Chemistry.
EXCITED STATE INTERMOLECULAR PROTON TRANSFER IN ISOLATED CLUSTERS: 1-NAPHTHOL/AMMONIA AND WATER
S. K. Kim, S. Li, and E. R. Bernstein 7 Mar. 1991 39 p
(Contract N00014-89-J-1237)
(AD-A233637; TR-73) Avail: NTIS HC/MF A03 CSCL 07/4

The excited singlet state intermolecular proton transfer reaction in jet-cooled clusters of 1-naphtho1/ammonia and water is investigated employing mass resolved excitation, threshold photoionization, and emission spectroscopy. The 1-naphthol(NH3)3 cluster for which proton transfer is indicated has a threshold photoionization energy roughly 2000 cm-1 below the other 1-naphthol(NH3)3 cluster configurations. These results are employed to explain the previous discrepancy between static spectroscopic experiments and picosecond time resolved dynamic experiments concerning proton transfer in the 1-naphthol(NH3)3 cluster. Calculations of cluster geometry in 1-naphthol/ammonia and water cluster systems suggest some qualitative explanations of these observations. GRA

N91-24858# International Centre for Theoretical Physics, Trieste (Italy).
THE JCM WITH INITIAL NUMBER-PHASE MINIMUM UNCERTAINTY STATE FIELD
Gau Ju (Tsinghua Univ., Bejing, China) and Li Shiqun Oct. 1990 8 p
(DE91-617584; LAMP-90/7) Avail: NTIS HC/MF A02

The Jaynes-Cummings interaction of a two-level atom with a quantized radiation field is studied when the field is initially in a Number-Phase Minimum Uncertainty State (NUS). The dynamic behavior of atomic inversion and field statistics is demonstrated in detail by numerical calculations. DOE

N91-24859# International Centre for Theoretical Physics, Trieste (Italy).
DYNAMIC TOROID POLARIZABILITY OF ATOMIC HYDROGEN
A. Costescu (Bucharest Univ., Romania) and E. E. Radescu Sep. 1990 81 p
(DE91-617732; IC-90/290) Avail: NTIS HC/MF A05

The concept of toroid polarizability introduced in previous work is examined within the familiar context of nonrelativistic quantum Coulomb systems, in a way unbiased by approximations. The dynamic (i.e., frequency (omega) dependent) toroid dipole polarizability gamma(omega) of a (nonrelativistic, spinless, ground-state) hydrogenlike atom is calculated analytically in terms of (essentially) one Gauss hypergeometric function. The static result takes on the simple form gamma(omega = 0) = (23/60) alpha(exp 2) Z(exp -4) a(sub 0)(exp 5) (alpha = fine structure constant, Z = nucleus charge number, a(sub 0) = Bohr radius). Gamma(omega) characterizes the linear response of the system to a conduction and/or displacement (time dependent) external current. The method of calculation (based on the use of the integral representation for the nonrelativistic Coulomb Green's function) is presented in detail. The imaginary part of gamma(omega) above ionization threshold is also computed in a simple closed form. Comparing gamma(omega = 0) with the already known (exact) results for the electric multipole polarizabilities (for which, as a byproduct, we present in an Appendix a considerably simplified expression, to our knowledge the simplest reported as yet), one sees that although for H-like atoms the toroid effects appear as very small indeed, they are however increasing with Z. A comparison with analogous (but, this time, only order of magnitude) evaluations for (charged) pions, indicates that the role of the induced toroid moments (as against that of the usual electric ones) increases drastically when passing from atomic to hadron physics; it is argued that this trend might continue further, at the sub-hadronic level. DOE

N91-24860# International Centre for Theoretical Physics, Trieste (Italy).
LASER RAMAN AND INFRARED SPECTROSCOPIC STUDIES OF MOLECULAR SYSTEMS: STRUCTURAL ANALYSIS OF SOME CLATHRATE COMPOUNDS
S. Akyuz Sep. 1990 16 p
(DE91-617733; LAMP-90/4) Avail: NTIS HC/MF A03

The structural analyses of some molecular systems, namely clathrates, depending on the laser Raman and infrared spectroscopic studies are reported. The following subject areas are covered: Raman effect; Raman spectroscopy; IR spectroscopy; mutual exclusion principle; vibrational spectra of the polymeric layers; and fundamental vibrations of pyrazine molecules. DOE

N91-24861# International Centre for Theoretical Physics, Trieste (Italy).
PHOTOELECTRON SPECTROSCOPY VIA ELECTRONIC SPECTROSCOPY OF MOLECULAR IONS
Z. H. Khan Oct. 1990 23 p
(DE91-617734; LAMP-90/6) Avail: NTIS HC/MF A03

In this work, a new aspect of the correlation between optical and photoelectron spectra is discussed on the basis of which the first ionization potentials of condensed-ring aromatics can be estimated from certain features in the electronic spectra of their positive ions. Furthermore, it is noticed that the first IP's are very sensitive to molecular size as the latter's inclusion in the regression formulas improves the results considerably. Once the first ionization potential for a molecule is determined, its higher IP's may be computed if the lower-energy electronic bands for its cation are known. This procedure is especially useful for such systems whose UV photoelectron spectra are unknown. DOE

N91-24862# International Centre for Theoretical Physics, Trieste (Italy).
THE EFFECT OF POLARIZATION OVER 2ND HARMONIC IN LASER LIGHT SCATTERING BY FREE ELECTRONS
V. P. Verma Sep. 1990 22 p
(DE91-617768; LAMP-90/5) Avail: NTIS HC/MF A03

In this work, the influence of linear as well as circular polarization on radiation at second harmonic frequency produced by nonlinear scattering of intense laser light by free electrons is studied in detail. It is shown that if incident beam is linearly polarized, the scattered radiation has acquired the nearly same polarization, but when the incident radiation field's polarization is turned over to a circular one, the observed light is, in general, elliptically polarized. For the scattering angle, theta = pi/2, the radiation becomes linearly polarized and when theta is small, there is no change in final polarization. DOE

N91-24863# Melbourne Univ., Parkville (Australia). School of Physics.
A STUDY OF TWO NUCLEON W-MATRICES
P. J. Dortmans and K. Amos 1990 19 p
(DE91-618203; UM-P-90/66) Avail: NTIS HC/MF A03

The free two nucleon W-matrices are studied for a number of two nucleon channels, including coupled channels, and over a range of lab. energies to 250 MeV. For realistic interactions these W-matrices are shown to be simple, smooth and real functions of (half-on-shell) momenta. The free two nucleon t-matrices are expanded in separable form by the W-matrices and the (fully-off-shell) remainder matrices that are left should have negligible effect in any (low energy) few body calculation. DOE

N91-24864# Melbourne Univ., Parkville (Australia). School of Physics.
HEXADECAPOLE SYSTEMATICS IN THE INTERACTING BOSON MODEL
S. Kuyucak, I. Morrison, and T. Sebe 1990 31 p
(DE91-618305; UM-P-90/77) Avail: NTIS HC/MF A03

The role of the hexadecapole degree of freedom in the description of band systematics in the rare-earth deformed nuclei is discussed. Using the 1/N expansion technique, it is shown that a self consistent treatment of the quadrupole and hexadecapole modes can describe experimental systematics in the interacting boson model. DOE

N91-24865*# Fermi National Accelerator Lab., Batavia, IL.
DIRAC NEUTRINOS AND SN 1987A
Michael S. Turner (Chicago Univ., IL.) May 1991 15 p
(Grant NAGw-1340)
(NASA-CR-188448; NAS 1.26:188448; FERMILAB-Pub-91/136-A)
Avail: NTIS HC/MF A03 CSCL 20H

Previous work has shown that the cooling of SN 1987A excludes a Dirac-neutrino mass greater than theta(20 keV) for nu(sub e), nu(sub mu), or nu(sub tau). The emission of wrong-helicity, Dirac neutrinos from SN 1987A, is re-examined. It is concluded that the effect of a Dirac neutrino on the cooling of SN 1987A has been underestimated due to neutrino degeneracy and additional emission processes. The limit that follows from the cooling of SN 1987A is believed to be greater (probably much greater) than 10 keV. This result is significant in light of the recent evidence for a 17 keV mass eigenstate that mixes with the electron neutrino. Author

N91-24866*# Fermi National Accelerator Lab., Batavia, IL.
ENERGETIC NEUTRINOS FROM HEAVY-NEUTRALINO ANNIHILATION IN THE SUN Ph.D. Thesis
Marc Kamionkowski (Chicago Univ., IL.) Apr. 1991 59 p
(Grant NAGw-1340)
(NASA-CR-188447; NAS 1.26:188447; FERMILAB-Pub-90/181-A)
Avail: NTIS HC/MF A04 CSCL 20H

Neutralinos may be captured in the sun and annihilated therein producing high-energy neutrinos. Present limits on the flux of such neutrinos from underground detectors such as IMB and Kamiokande 2 may be used to rule out certain supersymmetric dark matter candidates, while in many other supersymmetric models the rates are large enough that if neutralinos do reside in the galactic halo, observation of a neutrino signal may be possible in the near future. Neutralinos that are either nearly pure Higgsino or a Higgsino/gaugino combination are generally captured in the sun by coherent scattering off nuclei via exchange of the lightest Higgs boson. If the squark mass is not much greater than the

neutralino mass, then capture of neutralinos that are primarily gaugino occurs predominantly by spin-dependent scattering off hydrogen in the sun. The neutrino signal from annihilation of WIMPs with masses in the range of 80 to 1000 GeV in the sun should generally be stronger than that from weakly interacting massive particle (WIMP) annihilation in the earth, and detection rates for mixed-state neutralinos are generally higher than those for Higgsinos or gauginos. Author

N91-24867*# Fermi National Accelerator Lab., Batavia, IL.
LIGHT DOMAIN WALLS, MASSIVE NEUTRINOS AND THE LARGE SCALE STRUCTURE OF THE UNIVERSE
Alessandro Massarotti (Chicago Univ., IL.) Apr. 1991 13 p
(Grant NAGw-1340)
(NASA-CR-188446; NAS 1.26:188446; FERMILAB-Pub-91/104-A)
Avail: NTIS HC/MF A03 CSCL 20H

Domain walls generated through a cosmological phase transition are considered, which interact nongravitationally with light neutrinos. At a redshift z greater than or equal to 10(exp 4), the network grows rapidly and is virtually decoupled from the matter. As the friction with the matter becomes dominant, a comoving network scale close to that of the comoving horizon scale at z of approximately 10(exp 4) gets frozen. During the later phases, the walls produce matter wakes of a thickness d of approximately 10h(exp -1)Mpc, that may become seeds for the formation of the large scale structure observed in the Universe. Author

N91-24868*# Fermi National Accelerator Lab., Batavia, IL.
MULTI-DIMENSIONAL TUNNELLING AND COMPLEX MOMENTUM
Peter Bowcock (Chicago Univ., IL.) and Ruth Gregory Apr. 1991 26 p
(Contract DE-FG02-90ER-40560; NAGw-1340; NSF PHY-90-00036)
(NASA-CR-188445; NAS 1.26:188445; FERMILAB-Pub-91/103-A; EFI-91-19) Avail: NTIS HC/MF A03 CSCL 20H

The problem of modeling tunneling phenomena in more than one dimension is examined. It is found that existing techniques are inadequate in a wide class of situations, due to their inability to deal with concurrent classical motion. The generalization of these methods to allow for complex momenta is shown, and improved techniques are demonstrated with a selection of illustrative examples. Possible applications are presented. Author

N91-24869*# Fermi National Accelerator Lab., Batavia, IL.
TUNNELLING FROM NON-LOCALIZED INITIAL STATES
Peter Bowcock (Chicago Univ., IL.) and Ruth Gregory Apr. 1991 10 p
(Contract NAGw-1340; DE-FG02-90ER-40560; NSF PHY-90-00036)
(NASA-CR-188444; NAS 1.26:188444; FERMILAB-Pub-91/142-A)
Avail: NTIS HC/MF A02 CSCL 20H

An approach for calculating tunneling amplitudes from a nonlocalized initial state is presented. Generalizing the matching conditions and equations of motion to allow for complex momentum permits a description of tunneling in the presence of so-called classical motion. Possible applications of the method are presented. Author

N91-24870# Argonne National Lab., IL.
ADVANTAGES OF POLARIZATION EXPERIMENTS AT RHIC
D. G. Underwood 1990 6 p Presented at the Polarized Collider Workshop, University Park, 15-17 Nov. 1990
(Contract W-31-109-eng-38)
(DE91-011173; ANL-HEP-CP-91-11; CONF-9011177-8) Avail: NTIS HC/MF A02

We point out various spin experiments that could be done if the polarized beam option is pursued at RHIC. The advantages of RHIC for investigating several current and future physics problems are discussed. In particular, the gluon spin dependent structure function of the nucleon could be measured cleanly and systematically. Relevant experience developed in conjunction with the Fermilab Polarized Beam program is also presented. DOE

N91-24871# State Univ. Coll. of New York, Buffalo. Dept. of Chemistry.
HEISENBERG APPROACH TO PHOTON EMISSION NEAR A PHASE CONJUGATOR
Henk F. Arnoldus and Thomas F. George Mar. 1991 26 p
Prepared in cooperation with Villanova Univ., PA
(Contract N00014-90-J-1193)
(AD-A233585; UBUFFALO/DC/91/TR-43) Avail: NTIS HC/MF A03 CSCL 20/5

An expression for the emitted fluorescence radiation by an atom near a phase conjugator is derived from a plane-wave expansion of the electric field operator and Heisenberg's equation of motion for the annihilation operator. The result is compared to a solution which was found previously, based on the classical Maxwell equations, where it is shown that both theories yield the same expression for the field in the radiation zone, which confirms the correctness of either approach to the problem of optical phase conjugation of atomic radiation. GRA

N91-24980*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE IONIZING RADIATION ENVIRONMENT OF LDEF PRERECOVERY PREDICTIONS Abstract Only
John W. Watts, Jr., James H. Derrickson, T. A. Parnell, G. J. Fishman, A. Harmon, E. V. Benton, A. L. Frank, and Wolfgang Heinrich (Siegen Univ.,, Germany, F.R.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 11 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24981*# Naval Research Lab., Washington, DC.
GAMMA RADIATION SURVEY OF THE LDEF SPACECRAFT Abstract Only
G. W. Phillips, S. E. King, R. A. August, J. C. Ritter, J. H. Cutchin, P. S. Haskins, J. E. McKisson, D. W. Ely, A. G. Weisenberger, and R. B. Piercey (Mississippi State Univ., Mississippi State.) et al *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 12 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24982*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE INTERACTIONS OF ATMOSPHERIC COSMOGENIC RADIONUCLIDES WITH SPACECRAFT SURFACES Abstract Only
John C. Gregory, G. J. Fishman, A. Harmon, T. A. Parnell, G. Herzog, J. Klein, and A. J. T. Jull (Arizona Univ., Tucson.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 13 Submitted for publication (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24983*# Royal Aircraft Establishment, Farnborough (England). Space Dept.
SURFACE ACTIVATION OF CONCORDE BY Be-7 Abstract Only
P. R. Truscott, C. S. Dyer, and J. C. Flatman *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 14 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24984*# California Univ., Berkeley. Lawrence Berkeley Lab.
RADIOACTIVITIES OF LONG DURATION EXPOSURE FACILITY (LDEF) MATERIALS: BAGGAGE AND BONANZAS Abstract Only
Alan R. Smith and Donna L. Hurley *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 15 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24985*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
INDUCED RADIOACTIVITY IN LDEF COMPONENTS Abstract Only
B. A. Harmon, G. J. Fishman, T. A. Parnell, and C. E. Laird (University of Eastern Kentucky, Richmond.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 16 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24986*# Los Alamos National Lab., NM.
MEASUREMENTS OF INDUCED RADIOACTIVITY IN SOME LDEF SAMPLES Abstract Only
C. E. Moss and R. C. Reedy *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 17 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24987*# Massachusetts Inst. of Tech., Cambridge. Nuclear Reactor Lab.
CHARGED PARTICLE ACTIVATION STUDIES ON THE SURFACE OF LDEF SPACECRAFT Abstract Only
Ilhan Olmez, Forrest Burns, and Paul L. Sagalyn (Army Materials Technology Lab., Watertown, MA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 18 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24988*# Westinghouse Savannah River Co., Aiken, SC.
GAMMA RAY SPECTROMETRY OF LDEF SAMPLES AT SRS Abstract Only
Willard G. Winn *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 19 (For primary document see N91-24972 16-99)
(Contract DE-AC09-89SR-18035)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24989*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
CHARGED PARTICLE LET-SPECTRA MEASUREMENTS ABOARD LDEF Abstract Only
I. Csige, E. V. Benton, A. L. Frank, L. A. Frigo, E. R. Benton (San Francisco Univ., CA.), T. A. Parnell, and John W. Watts, Jr. *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 20 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24990*# Grumman Aerospace Corp., Bethpage, NY.
THERMOLUMINESCENT DOSIMETER MEASUREMENTS AND ANALYSIS FOR LDEF EXPERIMENT M0006 Abstract Only
Michael C. Stauber, J. Chang, and T. Kantorcik *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 21 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24991*# Science Applications International Corp., Prospect, TN.
RADIATION CALCULATIONS AND COMPARISONS WITH DATA Abstract Only
T. W. Armstrong and B. L. Colborn *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 22 Sponsored by Marshall Space Flight Center (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24992*# Science Applications International Corp., Prospect, TN.
LDEF GEOMETRY/MASS MODEL FOR RADIATION ANALYSES Abstract Only
B. L. Colborn and T. W. Armstrong *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 23 Sponsored by Marshall Space Flight Center (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24993*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
RADIATION EXPOSURE OF LDEF: INITIAL RESULTS Abstract Only
E. V. Benton, A. L. Frank, E. R. Benton, I. Csige (San Francisco Univ., CA.), T. A. Parnell, and John W. Watts, Jr. *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 24 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24995*# Hulburt (E. O.) Center for Space Research, Washington, DC.
PRELIMINARY RESULTS FROM THE HEAVY IONS IN SPACE EXPERIMENT Abstract Only
J. H. Adams, Jr., L. P. Beahm, and A. J. Tylka (Universities Space Research Association, Washington, DC.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 26 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24996*# Kiel Univ. (Germany, F.R.). Inst. fuer Reine und Angewandtd Kernphysik.
HEAVY ION MEASUREMENT ON LDEF Abstract Only
R. Beaujean, D. Jonathal, and W. Enge *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 27 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-24997*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
SUMMARY OF IONIZING RADIATION ANALYSIS ON THE LONG DURATION EXPOSURE FACILITY Abstract Only
T. A. Parnell *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 28 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-25016*# Boeing Aerospace and Electronics Co., Seattle, WA.
ATOMIC OXYGEN AND ULTRAVIOLET RADIATION MISSION TOTAL EXPOSURES FOR LDEF EXPERIMENTS Abstract Only
R. J. Bourassa, J. R. Gillis, and Ken W. Rousslang *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 48 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-25017*# Army Materials Technology Lab., Watertown, MA.
MEASUREMENT OF THE O18 TO O16 ISOTOPE RATIO FOR CHARACTERIZING OXIDE SURFACE LAYERS ON LDEF SAMPLES Abstract Only
Paul L. Sagalyn *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 49 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

N91-25027*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ATOMIC OXYGEN UNDERCUTTING OF LDEF ALUMINIZED KAPTON MULTILAYER INSULATION Abstract Only
Kim K. deGroh *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 60 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

N91-24872# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.

EFFECT OF THE FIELD GRADIENT OF AN INTENSE ELECTROMAGNETIC BEAM ON ELECTRONS AND ATOMS

G. A. Askaryan 2 Jan. 1991 13 p Transl. into ENGLISH from Zhurnal Eksperimentalnoy i Teoreticheskoy Fiziki (USSR), v. 42, no. 6, Jun. 1962 p 1567-1570

(AD-A233047; FTD-ID(RS)T-1379-90) Avail: NTIS HC/MF A03 CSCL 20/3

It is demonstrated that the transverse inhomogeneity of a strong electromagnetic ray can exert a strong effect on electrons and atoms of a medium. Thus, if the wave frequency exceeds the proper frequency the electron oscillations (in a plasma or in atoms), the electrons or atoms will be forced-out of the ray field. At sub-resonance frequencies the particles will be pulled in, the force being especially large at resonance. As a result of this effect a rarefaction or compression may occur in the ray or in the focus of the radiation; moreover the pressure gradient near the hole connecting the evacuated vessel with the atmosphere may be maintained and a channel conducting charged particles may be created in the medium. It is mentioned that a strong thermal, ionizing and separating effect of ray on the medium can be used for setting up wave guide conditions of propagation and for eliminating divergency of the ray (self-focusing). It is noted that hollow rays may ensure directed flow and ejection of the plasma along the ray axis for plasma transport and creation of plasma current conductors. The possibilities of acceleration and heating of plasma electrons by a modulated ray are indicated. GRA

N91-24873# Florida State Univ., Tallahassee. Dept. of Physics.

PULSED ELECTRON BEAM PRECHARGER

W. C. Finney, ed. 1990 52 p

(Contract DE-FG22-89PC-89768)

(DE91-010537; DOE/PC-89768/T2) Avail: NTIS HC/MF A04

A short review of electron beam particle precharging using a pulsed electric field is presented. The design and installation is detailed of a remote focusing gear train which will allow much greater control over the particle charge measurement capability of the charge vs. radius apparatus. Progress on the electrical shielding of the rotating spark gap power supply using a large Faraday cage is described. Efforts to prevent RFI interference from adversely affecting the Climet particle counter and the MicroMac current measurement device using a variety of techniques are also presented. The basic effort is to optimize the removal efficiency for fly ash particles. DOE

N91-24874# Argonne National Lab., IL.

PROTON-INDUCED FISSION AT ULTRA SUB-BARRIER ENERGIES

B. B. Back, R. R. Betts, P. B. Fernandez, J. C. Gehring, D. J. Henderson, and Y. Nagame 1991 8 p Presented at the 7th Winter Workshop on Nuclear Dynamics, Key West, 27 Jan. - 2 Feb. 1991

(Contract W-31-109-eng-38)

(DE91-011169; ANL/CP-72846; CONF-910135-2) Avail: NTIS HC/MF A02

Cross sections for proton-induced fission of U-238 have been measured at seven proton energies ranging from 3.0 to 4.45 MeV using two position sensitive parallel-grid avalanche counters in a kinematic coincidence. In addition, an upper limit for the fission cross section was established at extreme sub-barrier energies down to a level of approximately equal to 20 pb at 3 MeV. This result is in contradiction to recent findings of Ajitanand et al., who found that the fission excitation function exhibited a plateaux at about 1000 pb in the energy range from 1.0 to 3.5 MeV. DOE

N91-24875# Sandia National Labs., Albuquerque, NM.

MASS AND PERFORMANCE ESTIMATES FOR 5 TO 1000 kW(e) NUCLEAR REACTOR POWER SYSTEMS FOR SPACE APPLICATIONS

L. O. Cropp, D. R. Gallup, and A. C. Marshall Mar. 1991 54 p

(Contract DE-AC04-76DP-00789)

(DE91-010319; SAND-90-0312) Avail: NTIS HC/MF A04

Masses and radiator areas of typical space nuclear power concepts are estimated as a function of the continuous electrical power required during a ten-year mission. Results are presented as a function of power level in the range of 5 to 1000 kW electrical. Three general reactor types will be discussed: (1) the radiatively cooled Star-C reactor technology with thermionic conversion external to the core; (2) liquid metal cooled technology with pin-type thermionic fuel element conversion in the core; and (3) the liquid metal cooled SP-100 reactor technology with thermoelectric, Brayton, Stirling, and Rankine conversion systems. Mass estimates include all satellite subsystems except the payload itself. Area estimates include radiators to dump waste heat from the power conversion and power conditioning subsystems but not the payload. All system components utilize near-term technology with the exception of the Sp-100 Rankine and refractory Stirling concepts. DOE

N91-24876# Oak Ridge National Lab., TN.

THE DEVELOPMENT OF NEW RADIONUCLIDE GENERATOR SYSTEMS FOR NUCLEAR MEDICINE APPLICATIONS

F. F. Knapp, Jr., A. P. Callahan, S. Mirzadeh, C. Brihaye, and M. Guillaume (Liege Univ., Belgium) 1991 30 p Presented at the 4th European Symposium on Radiopharmacy and Radiopharmaceuticals, Baden (Switzerland), 1-4 May 1991

(Contract DE-AC05-84OR-21400)

(DE91-010381; CONF-910588-1) Avail: NTIS HC/MF A03

Radioisotope generator systems have traditionally played a central role in nuclear medicine in providing radioisotopes for both research and clinical applications. In this paper, the development of several tungsten-188/rhenium-188 prototype generators which provide rhenium-188 for radioimmunotherapy (RAIT) is discussed. The authors have recently demonstrated that carrier-free iridium-194 can be obtained from the activated carbon system from decay of reactor-produced osmium-194 for potential RAIT applications. Instrumentation advances such as the new generation of high-count-rate (fast) gamma camera systems for first-pass technology require the availability of generator-produced ultra short-lived radioisotopes for radionuclide angiography (RNA). The activated carbon generator is an efficient system to obtain ultra short-lived iridium-191 m from osmium-191 for RNA. In addition, the growing number of PET centers has stimulated research in generators which provide positron-emitting radioisotopes. Copper-62, obtained from the zinc-62 generator, is currently used for PET evaluation of organ perfusion. The availability of the parent radioisotopes, the fabrication and use of these generators, and the practical factors for use of these systems in the radiopharmacy are discussed. DOE

74 OPTICS

Includes light phenomena; and optical devices.

For lasers see *36 Lasers and Masers.*

N91-24877 Brown Univ., Providence, RI.

A BAYESIAN APPROACH TO 3-D SHAPE ESTIMATION FOR ROBOTIC VISION Ph.D. Thesis

Jose Ricardo deAlmei Torreao 1990 139 p

Avail: Univ. Microfilms Order No. DA9101846

The problem is considered of 3-D shape reconstruction for Computer Vision applications. The treatment is based on the Bayesian statistical approach, and an analogy is used between images and Statistical Mechanics systems to encode the expectations about the 3-D scene attributes and the image formation process in terms of Hamiltonians, from which prior probability distributions of Gibbs form are constructed. The shape

reconstruction protocol includes surface orientation estimation, edge detection, and depth map reconstruction. The Shape-from-Shading problem was reformulated in Bayesian terms of orientation map estimation from one undegraded input image, considering different Reflectance Map forms and various schemes for the incorporation of boundary conditions. The reconstruction of the orientation map was also considered from two degraded input images in the Photometric-Stereo frame work, i.e., for images obtained from the same viewing position with different illumination directions. For edge detection, two new approaches are introduced: the detection of boundaries from the orientation field input; and the use of multiple images for edge detection in a photometric-stereo framework. Dissert. Abstr.

N91-24878*# National Aeronautics and Space Administration. Pasadena Office, CA.

STEREOSCOPIC CAMERA AND VIEWING SYSTEMS WITH UNDISTORTED DEPTH PRESENTATION AND REDUCED OR ELIMINATED ERRONEOUS ACCELERATION AND DECELERATION PERCEPTIONS, OR WITH PERCEPTIONS PRODUCED OR ENHANCED FOR SPECIAL EFFECTS Patent Application

Daniel B. Diner, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 2 Nov. 1990 42 p
(Contract NAS7-918)
(NASA-Case-NPO-18028-1-CU; NAS 1.71:NPO-18028-1-CU; US-Patent-Appl-SN-608452) Avail: NTIS HC/MF A03 CSCL 20F

Methods for providing stereoscopic image presentation and stereoscopic configurations using stereoscopic viewing systems having converged or parallel cameras may be set up to reduce or eliminate erroneously perceived accelerations and decelerations by proper selection of parameters, such as an image magnification factor, q, and intercamera distance, 2w. For converged cameras, q is selected to be equal to Ve - qwl = 0, where V is the camera distance, e is half the interocular distance of an observer, w is half the intercamera distance, and l is the actual distance from the first nodal point of each camera to the convergence point, and for parallel cameras, q is selected to be equal to e/w. While converged cameras cannot be set up to provide fully undistorted three-dimensional views, they can be set up to provide a linear relationship between real and apparent depth and thus minimize erroneously perceived accelerations and decelerations for three sagittal planes, x = -w, x = 0, and x = +w which are indicated to the observer. Parallel cameras can be set up to provide fully undistorted three-dimensional views by controlling the location of the observer and by magnification and shifting of left and right images. In addition, the teachings of this disclosure can be used to provide methods of stereoscopic image presentation and stereoscopic camera configurations to produce a nonlinear relation between perceived and real depth, and erroneously produce of enhance perceived accelerations and decelerations in order to provide special effects for entertainment, training, or educational purposes. NASA

N91-24879# National Inst. of Standards and Technology, Boulder, CO. Electromagnetic Technology Div.

TECHNICAL DIGEST-SYMPOSIUM ON OPTICAL FIBER MEASUREMENTS, 1990

G. W. Day, ed. and D. L. Franzen, ed. Sep. 1990 211 p Symposium held in Boulder, CO, 11-12 Sep. 1990; cosponsored by IEEE and Optical Society of America
(PB91-132308; NIST/SP-792) Avail: NTIS HC/MF A10 CSCL 20F

Summaries are contained for 45 papers covering the topics of: industry standard measurements; COST 217 Program; optical fibers; optical properties; ODTR (optical time domain reflectometry; fiber geometry; optical measurements; spatial resolution; laser applications; polarization (waves); interferometric techniques; and fiber optics. B.G.

N91-24880 Columbia Univ., New York, NY.

OPTICAL INTERCONNECTION BY VERTICAL COUPLING OF SINGLE-MODE FIBERS TO SEMICONDUCTORS Ph.D. Thesis

Robert William Ade 1990 351 p
Avail: Univ. Microfilms Order No. DA9102395

Monolithically integrated microelectronic devices are increasing in speed and shrinking in size, while being packed with greater density onto ever larger substrates. The resulting need to transmit enormous amounts of information on and off single chips, without electromagnetic coupling between the closely-spaced signal lines, has spawned a new field: optical interconnection. Its aim is to provide many optical links between the physically separated semiconductor devices within a computing system. A significant advancement of the state of the art in optical interconnection is described. The techniques outlined permit vertical coupling of two-dimensional single-mode optical fiber arrays directly to semiconductor substrates, with a packing density of 16 fibers/sq mm. A diaphragm photodetector structure forms the basis of this approach to fiber optic interconnection. The structure features an epitaxial diaphragm consisting of thin (Al,Ga)As layers, which support metal-semiconductor photodiodes illuminated from the substrate side. The devices are compatible with high speed circuits and exhibit a response time below 50 picoseconds. The back illumination geometry suppresses interelement optical crosstalk an additional 20 dB, relative to previously reported fiber coupling techniques, and can double the optoelectronic conversion efficiency by avoiding the shadowing effect of contact metallization, which plagues many detector designs. The diphragms were fabricated by anisotropically and selectively removing parts of the GaAs substrate, to form cavities large enough to accommodate insertion of optical fibers, but small enough to permit close spacing of adjacent interconnections. Reactive ion etching in CCl2F2 was employed to etch through the substrate to an epitaxial Al(0.35)Ga(0.65)As stop-etch layer, in the first use of dry etching to fabricate such a structure. The etch process was also used to micromachine alignment fixtures for 2-D fiber optic array coupling. Several areas of research were explored. Advances in single-mode optical fibers were also explored. Advances in these areas led to the realization of the vertically coupled fiber optic interconnection concept, and to the demonstration of high performance device arrays. Dissert. Abstr.

N91-24881# Royal Signals and Radar Establishment, Malvern (England).

FORWARD OPTICAL SCATTERING FROM VERY ROUGH SURFACES NEAR GRAZING INCIDENCE

D. L. Jordan Aug. 1990 38 p
(AD-A233527; RSRE-Memo-4418; BR116080; ETN-91-99117)
Copyright Avail: NTIS HC/MF A03

A series of metal and dielectric targets exhibiting fractal characteristics are produced having a range of surface roughness between about 1 and 16 microns. They are all sufficiently rough that only diffuse reflection was obtained from them when illuminated with an HE-Ne laser beam. The intensity scattered in the specular direction was measured as a function of the surface roughness for near normal (20 deg) and near grazing (85 deg) incidence. The specular direction intensity at first falls rapidly with increasing surface roughness, but then saturates at high values of the surface roughness. Good agreement is obtained between the experimentally observed variation with surface roughness and that predicted theoretically using a fractal surface scattering model and surface parameters measured using a profile instrument. A simple graphical model is used to demonstrate qualitatively the trends observed. ESA

N91-24882*# Illinois Univ., Chicago. Dept. of Electrical Engineering and Computer Science.

ANISOTROPIC ELLIPTIC OPTICAL FIBERS Ph.D. Thesis

Soon Ahm Kang 1991 105 p Sponsored by Pacific Missile Test Center, Point Mugu, CA
(Grant NAG2-544)
(NASA-CR-188233; NAS 1.26:188233) Avail: NTIS HC/MF A06 CSCL 20F

The exact characteristic equation for an anisotropic elliptic optical fiber is obtained for odd and even hybrid modes in terms of infinite determinants utilizing Mathieu and modified Mathieu functions. A simplified characteristic equation is obtained by applying the weakly guiding approximation such that the difference in the refractive indices of the core and the cladding is small. The simplified characteristic equation is used to compute the normalized guide wavelength for an elliptical fiber. When the anisotropic parameter is equal to unity, the results are compared with the previous research and they are in close agreement. For a fixed value normalized cross-section area or major axis, the normalized guide wavelength lambda/lambda(sub 0) for an anisotropic elliptic fiber is small for the larger value of anisotropy. This condition indicates that more energy is carried inside of the fiber. However, the geometry and anisotropy of the fiber have a smaller effect when the normalized cross-section area is very small or very large. Author

N91-24883# Naval Ocean Systems Center, San Diego, CA.
A LIDAR TECHNIQUE FOR ADJUSTING AEROSOL MODEL NUMBER DENSITIES CLOSE TO THE OCEAN SURFACE
M. R. Paulson and H. G. Hughes Dec. 1990 19 p
(AD-A232042; NOSC/TR-1388) Avail: NTIS HC/MF A03
CSCL 20/6

With the Navy's interest in FLIR detectors at submarine periscope heights, it is important to get more detailed information on the atmospheric characteristics at FLIR wavelengths (3 to 5 and 8 to 12 microns) in the first few meters above the ocean. This information is particularly important for predicting the performance of electro-optical systems operating against skimmer-type missiles approaching a ship or submarine from beyond the horizon. A technique is introduced by which the total number density of the LOWTRAN 7 Navy Aerosol Model (NAM) (the kernel for the Naval Oceanic Vertical Aerosol Model) is adjusted to represent existing conditions close to the ocean surface. Measurements of bulk meteorological parameters at a reference height above the ocean surface are used to generate stability dependent logarithmic profiles of temperature and relative humidity. These profiles are used with the aerosol model to determine aerosol extinction and backscatter coefficient variations close to the ocean surface. Using the single-scatter lidar (light detection and ranging) equation, these parameters are then used to calculate a range compensated power, S(R), returned from scattering volumes at different heights in the modeled atmosphere. An iterative method is used by which the calculated S(R) values are adjusted to agree with the corresponding measured values obtained with a lidar operating at 1.06 microns and directed at the ocean over a slant path from an altitude of 10 meters. Examples of extinction coefficient variations with height above the ocean surface, calculated using the original and adjusted size distribution for different surface wind speed conditions and air-mass characteristics. GRA

N91-24884# Hughes Research Labs., Malibu, CA.
DIODE LASER SCALING USING UNCONVENTIONAL ADAPTIVE OPTICS Final Report, 1 Apr. 1987 - 31 Aug. 1990
W. J. Gignac, R. R. Stephens, A. A. Narayanan, R. R. Craig, and H. W. Yen Mar. 1991 70 p
(Contract N00014-87-C-0140)
(AD-A233060; HAC-REF-G1079-F) Avail: NTIS HC/MF A04
CSCL 09/1

The objectives of this program are to understand and develop technologies necessary for optimizing large area diode amplifiers that can be used in a phase conjugate (PC) master oscillator power amplifier (MOPA) arrangement to produce high power laser output. This report describes the study results on amplifier design, anti-reflection coating development, amplifier fabrication, and amplifier characterization. Author

N91-24885# University of Southern California, Los Angeles. Dept. of Electrical Engineering and Electrophysics.
NEW APPROACHES TO RECONFIGURABLE OPTICAL INTERCONNECTS Final Report, 1 Oct. 1989 - 30 Sep. 1990
William H. Steir 29 Nov. 1990 12 p
(Grant AF-AFOSR-0338-87; AF Proj. 2305)
(AD-A233064; AFOSR-91-0214TR) Avail: NTIS HC/MF A03
CSCL 20/6

The objective of this effort is to define and evaluate new approaches to two-dimensional arrays of reconfigurable optical interconnections and arrays of optical neurons for optical computing. The emphasis is on optically-controlled optical beam directors or switches and optically-saturated neurons which can be be fabricated into high density 2-D arrays. Using field shielding and optically-controlled electric field patterns in CdTe, controlled switching in the IR, infrared neurons with a variety of properties and optically-controlled beam deflection have been demonstrated. A study of organic nonlinear materials for potential use in charge transfer assisted optical switching devices is included. GRA

N91-24886# Texas A&M Univ., College Station.
SYMPOSIUM ON NEW MATERIALS FOR NONLINEAR OPTICS Final Report, 15 Apr. - 14 Oct. 1990
Seth R. Marder Jan. 1991 24 p Symposium held in Boston, MA, 22-26 Apr. 1990
(Grant AF-AFOSR-0216-90; AF Proj. 2303)
(AD-A233068; AFOSR-91-0172TR) Avail: NTIS HC/MF A03
CSCL 20/6

The New Materials for Nonlinear Optics Symposium was held at the American Chemical Society National Meeting, in Boston on April 22 to 26, 1990. The meeting was a success. Throughout the week the average attendance was over 150 people/session. Several speakers had attendance over 300. The ACS organized a press conference about the meeting, held on Wednesday April 25, 1990 at 2 pm. At the time, the organizers devoted considerable time to educating the press about the importance of NLO research and the potential impact the NLO devices will have on the average person. The American Chemical Society is publishing an ACS Symposium Series monograph edited by the symposium organizers, to provide a permanent record of the proceeding of this meeting. GRA

N91-24887# Pittsburgh Univ., PA.
COINCIDENT PULSE TECHNIQUES FOR HYBRID ELECTRONIC OPTICAL COMPUTER SYSTEMS Annual Technical Report, Jul. 1989 - Jul. 1990
Donald M. Chiarulli, Rami G. Melhem, and Steven P. Levitan 31 Aug. 1990 120 p
(Grant AF-AFOSR-0469-89; AF Proj. 2305)
(AD-A233195; AFOSR-91-0202TR) Avail: NTIS HC/MF A06
CSCL 20/6

This research was an investigation of the application of coincident pulse techniques to multiprocessor interconnection networks. The research focused on three main areas: an examination of the applicability of coincident pulse techniques and required hardware to multiprocessor applications, an investigation of the limits of scalability, and an exploration of various interconnection structures which can be created using these techniques. GRA

N91-24888# Naval Ocean Systems Center, San Diego, CA.
WIDE-BAND RF SIGNAL PROCESSING WITH OPTOELECTRONIC DEVICES AND FIBER-OPTIC DELAY LINES
M. H. Berry and D. M. Gookin Dec. 1990 24 p
(AD-A233388; NOSC/TR-1385) Avail: NTIS HC/MF A03
CSCL 20/6

This report discusses a new technology for processing wide-band, greater than 1 GHz, RF signals with a large dynamic range. Fiber-optic delay lines and optoelectronic devices were used to build and test a finite impulse response (FIR) filter and a wide-band differential amplifier. Other applications, including radar beamforming and pulse compression are described. These devices work in realtime. GRA

N91-24889# PCO, Inc., Chatsworth, CA.
COHERENT FIBER OPTIC LINKS Final Report

B. T. Debney, J. Hankey, P. Johnson, and J. Buus Dec. 1990 108 p
(Contract F30602-86-C-0014)
(AD-A233465; RADC-TR-90-381) Avail: NTIS HC/MF A06 CSCL 25/5

This report contains the results of the development and testing of a digital coherent fiber optic link and a separate analog coherent fiber optic link. The issues of realizable performance, cost, and complexity of implementation and device tolerances are covered for each within a theoretical framework. The digital coherent fiber optic link was one of only two nearly simultaneously appearing 19-inch rack mountable systems in the world. The analog coherent fiber optic link is the first of its kind in the world and new ground is covered in theoretical analysis. In addition, the self heterodyne/homodyne concept is described and experimental results are shown. GRA

N91-24890# Tufts Univ., Medford, MA. Electro-Optics Technology Center.
PHOTOREFRACTIVE NONLINEAR OPTICS Final Report, 28 Sep. 1987 - 27 Oct. 1990
Mark Cronin-Golomb 15 Jan. 1991 29 p
(Contract DAAL03-87-K-0141)
(AD-A233468; ARO-25154.25-PH) Avail: NTIS HC/MF A03 CSCL 20/6

This program succeeded in developing several photorefractive devices. One is a distortion compensating phase conjugate interferometer for the measurement of thin film thickness, refractive index and absorption coefficients. Also, we have investigated achromatic volume holography for adaptive optics applications. We have been working also on a device for passive mode locking of semiconductor lasers and have shown self pumped phase conjunction at 1.32 micrometers, the longest wavelength to date at which self-pumped phase conjugation has been observed. An understanding now exists of temporal instabilities in photorefractive phase conjugate mirrors. We are beginning to understand the effects of reduced spatial coherence in photorefractive devices, and using concepts developed in that work, we have analyzed our observations of high diffraction efficiency femtosecond two beam coupling in photorefractive crystals. GRA

N91-24891# TRW Space Technology Labs., Redondo Beach, CA.
NONLINEAR OPTICS TECHNOLOGY. VOLUME 1: SOLID STATE LASER TECHNOLOGY, PHASE 3 Final Report, Mar. 1988 - Nov. 1990
J. Brock, R. Chan, L. Lembo, J. Ho, and H. Injeyan 12 Jan. 1991 107 p
(Contract N00014-88-C-0228)
(AD-A233533) Avail: NTIS HC/MF A06 CSCL 09/3

A novel regenerative amplifier concept, suitable for extraction from low gain, high saturation fluence, solid state media has been investigated. The concept is called multipass etalon-coupled conjugated amplifier (MECCA) and uses an etalon and a SBS cell or other frequency shifting medium to form a regenerative amplifier cavity. The beam is injected into the cavity through a transmission window of the etalon and is trapped in the cavity when the frequency is shifted. The beam is extracted by encountering another transmission window after a predetermined number of round trips as it marches in frequency space. Two MECCA configurations were tested. One uses SBS to provide the frequency shift the other uses an acousto-optic modulator. Using the SBS medium in a multipass configuration with short pulses caused rapid degradation of the SBS reflectivity and fidelity due to the thermalization of the SBS grating between pulses, which resulted in poor extraction and beam quality. Both extraction and beam quality were improved when the cavity was shortened to provide partial beam overlap in the SBS cell and sustained driving fields. GRA

N91-24892 Department of the Navy, Washington, DC.
EFFICIENT DYNAMIC PHASEFRONT MODULATION SYSTEM FOR FREE-SPACE OPTICAL COMMUNICATIONS Patent
G. C. Gilbreath, inventor (to Navy) and Frederic M. Davidson, inventor (to Navy) 22 Jan. 1991 15 p Filed 9 Sep. 1988
(AD-D014839; US-Patent-4,987,607; US-Patent-Appl-SN-242678; US-Patent-Class-455-618) Avail: US Patent and Trademark Office CSCL 20/6

An optical communications system is disclosed for correcting in real time the wavefront distortions of a beam from a coherent optical transmitting source. The system includes a collimating lens and beam splitter for receiving a distorted wavefront signal beam and splitting the beam into a pump beam and a weaker intensity signal beam. The system includes a detector and computer for measuring the beam distortion and specifying a compensatory wavefront. The weaker intensity signal beam is modified in a 2-D spatial light modulator according to a compensatory wavefront. A photo-refractive material is used to couple energy from the pump beam to the compensated wavefront signal beam thereby producing a corrected and intensity-enhanced communications beam. GRA

N91-24893 Department of the Navy, Washington, DC.
OPTICAL FIBER REFRACTOMETER LAUNCHING LIGHT AT A NON-ZERO LAUNCH ANGLE Patent
Lloyd C. Bobb, inventor (to Navy) and Howard D. Krumboltz, inventor (to Navy) 29 Jan. 1991 10 p Filed 3 Jan. 1990
(AD-D014841; US-Patent-4,988,863; US-Patent-Appl-SN-460436; US-Patent-Class-250-227.25) Avail: US Patent and Trademark Office CSCL 17/5

The index of refraction of a liquid is measured using an optical fiber refractometer having a light transmitting optical fiber by immersing a portion of the optical fiber in the liquid and launching light into one end of the optical fiber at a selected non-zero launch angle with respect to the fiber axis. Light transmitted through the optical fiber is detected at the other end of the optical fiber and a determination is made of the index of refraction of the liquid in accordance with the detected light and the selected non-zero launch angle. By varying the launching angles of the light the range of the refractometer is increased. The light transmitting optical fiber is provided with a region having at least one tapered portion for further increasing the range of the refractometer. The tapered portion of the optical fiber is disposed between a refractive end of the optical fiber and the light source for providing single-ended operation. GRA

N91-24894# Department of the Navy, Washington, DC.
OPTICAL FIBER REFRACTOMETER Patent Application
Lloyd C. Bobb, inventor (to Navy) and Howard D. Krumboltz, inventor (to Navy) 16 Jul. 1990 28 p
(AD-D014845; US-Patent-Appl-SN-553040) Avail: NTIS HC/MF A03 CSCL 17/5

The index of refraction of a liquid is measured using an optical fiber refractometer having a light transmitting optical fiber by immersing a portion of the optical fiber in the liquid and launching light into one end of the optical fiber at a selected non-zero launch angle with respect to the fiber axis. Light transmitted through the optical fiber is detected at the other end of the optical fiber and a determination is made of the index of refraction of the liquid in accordance with the detected light and the selected non-zero launch angle. By varying the launching angles of the light the range of the refractometer is increased. The light transmitting optical fiber is provided with a region having at least one tapered portion for further increasing the range of the refractometer. The tapered portion of the optical fiber is disposed between a reflective end of the optical fiber and the light source for providing single-ended operation. GRA

N91-24895# Sandia National Labs., Albuquerque, NM.
DETERMINATION OF RESULTANT TORQUE ON A ROTARY SOLENOID USING A BIAXIAL DISPLACEMENT FOLLOWER
D. W. Plummer Mar. 1991 17 p
(Contract DE-AC04-76DP-00789)
(DE91-010614; SAND-90-2892) Avail: NTIS HC/MF A03

This report describes a method to determine the resultant torque acting on a rotary solenoid. An electro-optical biaxial displacement follower was used to track the position of a point on the solenoid

rotor during a time interval. The displacement-versus-time information was differentiated twice and the resultant torque on the system was calculated using Newton's second law of motion. This paper describes the use of this technique on one electromechanical component and is an introduction to the use of a biaxial displacement follower for similar applications. The technique could be applied to any rotary or translatory system where the external moments or forces are difficult to quantify.
DOE

N91-24896# City Univ. of New York, NY.
NON-GEOMETRICAL OPTICS STUDY OF WAVE PROPAGATION
K. Imre (City Univ. of New York, NY.) Feb. 1990 8 p
(Contract DE-FG02-86ER-53233)
(DE91-010616; DOE/ER-53233/2) Avail: NTIS HC/MF A02

Heating of plasmas in large toroidal devices using electromagnetic waves with frequencies in the range of ion cyclotron resonance frequency is investigated in the case when in the resonance region the majority ions are in the second harmonic resonance and the minority ions are in the fundamental resonance. Particular attention is given to the case when the effects of the poloidal component of the equilibrium magnetic field significantly alter the wave propagation characteristics across the resonance region. The effects of anisotropic distribution functions on ion cyclotron range of frequencies (ICRF) heating were examined. A study on the problem of controlling the fusion generated high energy alpha ash by means of carefully prepared spatially anisotropic ICRF electromagnetic fields was initiated. Preliminary investigations restricted to the long-thin geometries were performed, and the relevancy of such a scheme was demonstrated. The extension of this study to general tokamak geometries with specified equilibrium flux surfaces is under consideration.
DOE

N91-24897# International Centre for Theoretical Physics, Trieste (Italy).
THEORETICAL PREDICTION OF NONLINEAR BREWSTER ANGLE IN ADP
V. Bhanthumnavin and N. Ampole (King Mongkut's Inst. of Tech., Bangkok, Thailand) Mar. 1990 8 p
(DE91-617792; LAMP-90/2) Avail: NTIS HC/MF A02

The intensity of reflected second harmonic light from the uniaxial Ammonium di-Hydrogen Phosphate, (NH4H2PO4)-ADP crystal immersed in optically denser liquid 1-bromonaphthalene has been theoretically investigated as a function of the incident angle of the fundamental beam of a Nd:YAG laser. The ADP crystal was assumed to be cut with its optics axis zone axes (001) inclining at angle theta = 42.05 deg to the incident surface. The incident fundamental beam has its polarization along zone axes (11'0) direction which is normal to the plane of incidence. The intensity of second harmonic light is calculated with the theory of Bloembergen and Pershan. A Nonlinear Brewster Angle theta(sub i)(sup N.B.) of 43.32 deg is predicted.
DOE

N91-24898*# Loral Defense Systems, Akron, OH.
THE 3D LASER RADAR VISION PROCESSOR SYSTEM Final Report
T. M. Sebok Oct. 1990 41 p
(Contract NAS9-18187)
(NASA-CR-185640; NAS 1.26:185640; ER-17453) Avail: NTIS HC/MF A03 CSCL 20F

Loral Defense Systems (LDS) developed a 3D Laser Radar Vision Processor system capable of detecting, classifying, and identifying small mobile targets as well as larger fixed targets using three dimensional laser radar imagery for use with a robotic type system. This processor system is designed to interface with the NASA Johnson Space Center in-house Extra Vehicular Activity (EVA) Retriever robot program and provide to it needed information so it can fetch and grasp targets in a space-type scenario.
Author

N91-24899# Hughes Research Labs., Malibu, CA.
REAL-TIME IMPLEMENTATION OF NONLINEAR OPTICAL DATA PROCESSING FUNCTIONS Final Report, Mar. 1988 - Jun. 1990
Yuri Owechko and Bernard Soffer Nov. 1990 109 p
(AD-A233521; HAC-REF-G4385; AFOSR-91-0198TR) Avail: NTIS HC/MF A06 CSCL 12/7

Efforts toward optical implementations of neural network models are described. The parallelism of optics will allow the hardware implementation of very large numbers of neurons with high throughputs. Under this effort, the development of the stimulated photorefractive optical neural network (SPONN) was initiated. The SPONN is a hybrid optoelectronic system for programmable, adaptive, and fully parallel direct physical implementations of neural network models which is based on self-pumped photorefractive phase conjugate mirrors.
GRA

N91-25069*# Georgia Tech Research Inst., Atlanta.
LDEF ACTIVE OPTICAL SYSTEM COMPONENTS EXPERIMENT Abstract Only
M. D. Blue *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 103 (For primary document see N91-24972 16-99)
(Contract NAS1-14654)
Avail: NTIS HC/MF A07 CSCL 20F

N91-25079*# Naval Weapons Center, China Lake, CA.
SPACE ENVIRONMENTAL EFFECTS ON COATED OPTICS Abstract Only
T. M. Donovan, J. M. Bennett, and S. R. Gyetvay (Aerospace Corp., Los Angeles, CA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 113 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20F

N91-25080*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
LDEF FIBER OPTIC EXPOSURE EXPERIMENT Abstract Only
Alan R. Johnston, Larry A. Bergman, and Ron Hartmayer *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 114 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20F

N91-25081*# Air Force Systems Command, Kirtland AFB, NM. Optoelectronics Section.
PRELIMINARY ANALYSIS OF WL EXPERIMENT NUMBER 701: SPACE ENVIRONMENT EFFECTS ON OPERATING FIBER OPTIC SYSTEMS Abstract Only
E. W. Taylor, R. J. Padden, J. N. Berry, A. D. Sanchez, and S. P. Chapman *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 115 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20F

75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

N91-24900# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
REPORT OF THE ACTIVITIES OF THE LABORATORIO ASSOCIADO DE PLASMA OF INPE IN THE BIENNIUM 88/89 [RELATORIO DE ATIVIDADES DO LABORATORIO ASSOCIADO DE PLASMA DO INPE NO BIENIO 88/89]
Gerson Otto Ludwig, comp. Nov. 1990 98 p In PORTUGESE
(INPE-5201-PRE/640) Avail: NTIS HC/MF A05

The development activities during the period of 1988 to 1989 are described. Presented are the principle results obtained in the three lines of research and development of LAP (Laboratorio

Associado de Plasma): plasma physics, plasma technology, and controlled nuclear fusion. Transl. by B.G.

N91-24901# Aerospatiale Aquitaine, Saint-Medard en Jalles (France).
PLASMA TORCHES AT BLAST FURNACE: FOUR YEARS OF INDUSTRIAL EXPERIENCE IN FRANCE
Y. deLassatdePressigny, R. Drelon, A. Butel (Societe du Ferro-Manganese de Paris Outreau, Boulogne-sur-Mer, France), M. Labrot, and D. Pineau 1991 14 p Presented at the EPRI/CMP Plasma Symposium, Palo Alto, CA, Mar. 1990
(Rept-911-430-124; ETN-91-99296) Avail: NTIS HC/MF A03

The industrial development of plasma systems at blast furnace in France is adressed. The aims of plasma utilization are outlined. An increase of blast temperature is usually limited to about 1250 C by the technology of hot blast stoves and plasma torches open a possibility of overpassing this limit. High coke rates required for ferromanganese production and the introduction of electricity to save coke are discussed. Experiences of plasma in the blast furnace, leading towards greater energy and production flexibility, are described. Plasma systems may now be considered as proven industrial technology for blast furnace and electricity a usable energy for primary metal production. ESA

N91-24902# Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering.
INTENSE MICROSECOND ELECTRON BEAM INTERACTIONS WITH LOW PRESSURE GASES Final Report, 15 Aug. 1985 - 31 Dec. 1988
Ronald M. Gilgenbach, M. L. Brake, and T. Kammash 28 Feb. 1991 45 p
(Contract N00014-81-K-0542)
(AD-A233004) Avail: NTIS HC/MF A03 CSCL 15/6

The major purpose of this project was to examine the ultra-violet to visible emission spectra produced by intense, relativistic long pulse electron beam interactions with gas and plasma environments. Two electron beam accelerators were used in the interaction experiments. The first was MELBA (Michigan Electron Long Beam Accelerator) which operates at the following parameters: Pulselength 1 to 4 microsec, Voltage - 0.7 to 1.0 MV; Current 1 - 30 kA. A second electron generator (Febetron) with long-pulse modules was also employed: pulselength 0.4 microsec fullwidth: voltage 0.3 to 0.5 MV; current 1.4 kA. State of the art optical diagnostics were used to examine the ultra-violet to visible radiation produced by the interaction of the electron beam with gases and plasmas. The two types of gases studied were rare gases (helium, neon, argon, krypton and xenon) and air mixtures (either nitrogen or dry bottled air). The spectrum was measured by either: (1) a low resolution (0.275 m) spectrograph or a high resolution (1 m) spectrograph and an intensified optical multichannel analyzer or a photomultiplier tube. The emission spectroscopy studies concentrated on identification of the spectral lines from 180 to 800 nm. Various plasma parameters were determined from the optical emission. GRA

N91-24903# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
EMISSION MECHANISM OF PLASMA-INDUCED FIELD-EMISSION CATHODE
Zhang Qi and Jiahe Lu 23 Oct. 1990 18 p Transl. into ENGLISH from Dianzixue Tongxun (Peoples Rep. of China), v. 5, no. 5, Sep. 1983 p 313-319
(AD-A233056; FTD-ID(RS)T-0589-90) Avail: NTIS HC/MF A03 CSCL 20/9

The paper generally describes the physical model of a plasma-induced field-emission cathode; the emission mechanism is based on cathode emission spots with the detonation of cathode microtip. GRA

N91-24904# Wisconsin Univ., Madison. Center for Plasma Theory and Computation.
FLUID/KINETIC HYBRID MOMENT DESCRIPTION OF PLASMAS VIA A CHAPMAN-ENSKOG-LIKE APPROACH Ph.D. Thesis
Jianping Wang Mar. 1991 64 p
(Contract DE-FG02-86ER-53218)
(DE91-010969; UW-CPTC-91-1) Avail: NTIS HC/MF A04

A combined fluid and kinetic description of magnetically confined plasmas is developed via a Chapman-Enskog-like procedure. This approach uses the density, energy, momentum, and heat flow conservation equations to recast the plasma kinetic equation with a full Fokker-Planck collision operator into an equation for F, the departure of the distribution function from a heat flow distorted dynamic Maxwellian. A density, momentum, and energy conserving Coulomb collision operator model is utilized in deriving the final form of the recast kinetic equation. The recast kinetic equation for the kinetic distortion F has been developed as follows. First, large flow velocities have been allowed for throughout the dynamics while an approximation has been used to simplify the Coulomb collision operator. Both the test particle and field particle parts of the Coulomb collision operator are retained and shown to cancel various frictional force and energy dissipation terms in appropriate limits. A drift kinetic limit of the dynamics and of the collisional effects is developed and shown to reproduce and extend previous derivations. Closure of the fluid moment equations through calculation of the anisotropic stress tensor (Pi) and anisotropic heat stress tensor (Theta) from the kinetic solution for F is discussed. As an application of this work, a more direct derivation of the flux-surface-averaged parallel viscous forces, which yield the neoclassical transport effects, has been developed by deductively applying the formalism developed in this thesis. Also, the poloidal variation of these viscous forces in the banana collisionality regime has been determined for the first time using this new formalism. Finally, preliminary studies of dynamical effects on the neoclassical viscous stresses are also discussed. DOE

N91-24905# Wisconsin Univ., Madison.
UNIFIED PLASMA FLUID/KINETIC EQUATIONS FOR TOKAMAK MICROINSTABILITY AND TURBULENCE STUDIES Ph.D. Thesis
Zuoyang Chang Mar. 1991 96 p
(Contract DE-FG02-86ER-53218)
(DE91-011010; UW-CPTC-91-2) Avail: NTIS HC/MF A05

Unified fluid/kinetic equations for the plasma perturbed density (tilde n), parallel flow velocity (tilde u(sub parallel)) and temperature (tilde T) are developed by calculating the fluid moment closure relations kinetically. At first, a set of (unclosed) perturbed fluid equations for tilde n, tilde u(sub parallel) and tilde T is developed using a drift ordering analysis and a new gyroviscous force (delta x Pi(sub g)) derived from the stress tensor (Pi) evolution equation. Thereafter, to develop linear closure relations for b x delta x tilde Pi(sub parallel) and delta x tilde q, a drift-kinetic version of a Chapman-Enskog-type equation suitable for toroidal magnetic geometry is derived. In a sheared slab geometry this equation is solved using a moment approach and a physically realistic collision operator (Lorentz scattering operator plus the momentum restoring terms). The resultant closure relations for tilde pi(sub parallel) and tilde q(sub parallel) unify both the fluid and kinetic properties. In the fluid collisional limit the equations reduce to the well-known Braginskii equations. In the adiabatic limit they reproduce the usual kinetic results, including Landau damping. It is shown that the Chapman-Enskog-type approach is more compatible with a fluid-like description of plasmas than the usual gyrokinetic approach. Remarkable simplification of these complicated closure relations is achieved. The results are compared with other recently developed Landau damping models and shown to be more accurate and complete. DOE

N91-24906# Massachusetts Inst. of Tech., Cambridge. Plasma Fusion Center.
FUSION DEVELOPMENT AND TECHNOLOGY

D. B. Montgomery 1991 59 p
(Contract DE-FG02-91ER-54110)
(DE91-011076; DOE/ER-54110/T2) Avail: NTIS HC/MF A04

This report discusses the following topics: superconducting magnet technology high field superconductors; advanced magnetic system and divertor development; poloidal field coils; gyrotron development; commercial reactor studies - Aries; ITER physics; ITER superconducting PF scenario and magnet analysis; and safety, environmental and economic factors in fusion development. DOE

N91-24907# Melbourne Univ., Parkville (Australia). School of Physics.
RELATIVISTIC SPIN-ONE BOSON PLASMA
J. Daicic and N. E. Frankel 1990 43 p
(DE91-617613; UM-P-90/74) Avail: NTIS HC/MF A03

The polarization tensor is derived for a system of charged spin-one bosons and antibosons in the case of no external magnetic field. This requires a thorough exposition of relativistic spin-one quantum mechanics, and thus the initial focus was upon the Sakata-Taketani equation and its free-field solutions. The results were then used to evaluate the matrix elements required for the calculation of the polarization tensor, which itself is derived via the self-consistent random-phase approximation (RPA) method. It is from this tensor that the longitudinal and transverse dielectric response functions for this plasma were obtained. These response functions were then evaluated at zero temperature, and exhibit the characteristic modes of oscillation. Finally, possible generalizations of this work, in particular to a finite-temperature plasma, and to one with an external magnetic field are discussed. DOE

N91-24908# Wisconsin Univ., Madison. Dept. of Physics.
THEORETICAL STUDIES OF TURBULENCE AND ANOMALOUS TRANSPORT IN TOROIDAL CONFINEMENT DEVICES
P. W. Terry 1991 15 p
(Contract DE-FG02-89ER-53291)
(DE91-011071; DOE/ER-53291/2) Avail: NTIS HC/MF A03

The research performed under this grant has focused on key issues with respect to turbulence and transport in toroidal confinement devices. This work includes theoretical and computational studies of electron thermal confinement which have concentrated on the role of sheared poloidal flow in suppressing turbulence and transport, trapped ion convective cell turbulence and microtearing turbulence; analytical studies of anomalous particle transport and pinch mechanisms and comparison with experimental measurement; development of the theory of self-consistent radial transport of field-aligned momentum in the tokamak and RFP; and work on other topics (ion temperature gradient driven turbulence, RFP fluctuation theory, coherent structures). Progress and publications in these areas are summarized in this report. DOE

76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

N91-24909*# Georgia Inst. of Tech., Atlanta.
CRYSTALLIZATION OF PROTEINS BY DYNAMIC CONTROL OF SUPERSATURATION Ph.D. Thesis Semiannual Status Report, 21 Mar. - 20 Sep. 1990
Lori June Wilson Nov. 1990 213 p
(Grant NAG8-713)
(NASA-CR-188193; NAS 1.26:188193) Avail: NTIS HC/MF A10 CSCL 20L

The growth of protein crystals is known to be the limiting factor in the determination of the three-dimensional structures of most proteins. It is expected that the kinetics of supersaturation, which is directly related to solvent evaporation, will affect protein crystal growth and nucleation and accordingly determine the quality, number, size, and morphology of the crystals. With a technique that controls the evaporation of solvent from a protein solution with N2(g) it is possible to determine the effect of different evaporation profiles on hen egg white lysozyme crystals. Hen egg white lysozyme was chosen as the model protein because it crystallizes easily and has solubility data available for most salt, pH, and temperature ranges. Commercially available lysozyme was further purified by a number of methods. Crystals grown with the purified lysozyme and with the unpurified lysozyme in citrate buffer were different shapes but were found to be of the same symmetry space group by precession photos. Differences were seen in the lysozyme crystals grown using different evaporation rates. At three of the four initial conditions for lysozyme crystal growth, longer evaporation times yielded better crystals. The evaporation times required to see a change in the appearance of the crystals was much longer than expected. The number of rates studied so far represent only a small fraction of the ones now available with the gas evaporation device. The technique also provides for control of both solution pH and temperature which are related to the solubilities of proteins. Author

N91-24910# Quaid-i-Azam Univ., Islamabad (Pakistan). Dept. of Physics.
CAPTURE CROSS SECTION MEASUREMENTS ON DEEP LEVELS IN SEMICONDUCTORS M.S. Thesis
Ata-Ul-Habib Khalid Jul. 1990 170 p
(PB91-130146) Avail: NTIS HC/MF A08 CSCL 20L

Two basic tasks were completed: (1) the development of the pulse train technique to measure the capture cross-section of deep levels in semiconductors and its testing, and (2) the use of this technique for the measurement of capture cross-section (and its temperature dependence) of the recently observed mid-gap level in platinum and doped silicon. A new circuit was developed for the pulse train technique, modifying some of the previously reported circuitry for such measurements. The capture cross-section of the platinum related mid-gap level was found. This cross-section was found to be temperature independent in the range of 94.6 to 163 K. This result also shows that the energy position of E(c) -0.55 eV reported earlier from DLTS measurements is the correct energy position of the level and does not require any modification due to the temperature dependence of the capture cross-section. Author

N91-24911# Quaid-i-Azam Univ., Islamabad (Pakistan). Dept. of Physics.
THE EFFECT OF IMPURITIES ON HIGH TEMPERATURE BI-BASED SUPERCONDUCTORS M.S. Thesis
Salamat Ali 1990 83 p
(PB91-130120) Avail: NTIS HC/MF A05 CSCL 20L

To study the formation of High Temperature Superconductors, the system Bi-Pb-Sr-Ca-Cu-O was undertaken. The compositions (Bi(1-x)Pb(x)) 2Sr2Ca2Cu3Oy with x = 0, 0.1, 0.2, 0.25, and 0.3 were studied at length. The experiments indicated that the formation of phases depends on the type of thermal procedure adopted. Below or above x = 0.2, always mixed phases are formed, while the pure high temperature phase is obtained for x = 0.2. It is interesting to note that this later composition is independent of the thermal procedure. This phenomenon points to formation of boundaries, perhaps due to the incorporation of impurities into the lattice. Author

N91-24912*# Florida Inst. of Tech., Melbourne. Dept. of Physics and Space Sciences.
IMPROVEMENT OF PROGRAM TO CALCULATE ELECTRONIC PROPERTIES OF NARROW BAND GAP MATERIALS Final Summary Report, 15 Jun. 1989 - 15 Jun. 1991
James D. Patterson and Wafaa Abdelhakiem 15 Jun. 1991 31 p
(Grant NAG8-781)
(NASA-CR-188212; NAS 1.26:188212) Avail: NTIS HC/MF A03 CSCL 20L

The program was improved by reprogramming it so it will run on both a SUN and a VAX. Also it is easily transportable as it is

on a disk for use on a SUN. A computer literature search resulted in some improved parameters for Hg(1-x)Cd(x)Te and a table of parameters for Hg(1-x)Zn(x)Te. The effects of neutral defects were added to the program, and it was found, as expected, that they contribute very little to the mobility at temperatures of interest. The effect were added of varying the following parameters: dielectric constants, screening parameters, disorder energies, donor and acceptor concentrations, momentum matrix element, different expressions for energy gap, and transverse effective charge.
Author

N91-24913# State Univ. of New York, Buffalo. Dept. of Chemistry.
INTERFACE-PHONON-MEDIATED MAGNETOPOLARONIC EFFECT ON IMPURITY TRANSITION ENERGIES IN QUANTUM WELLS
D. L. Lin, R. Chen, and Thomas F. George Feb. 1991 18 p
(Contract N00014-90-J-1193)
(AD-A232390; UBUFFALO/DC-91-TR-42) Avail: NTIS HC/MF A03 CSCL 20/12

Electron interactions with interface phonon modes and strictly-confined bulk phonon modes are considered for the first time to calculate the resonant magnetopolaronic 1s-2p(+) transition energy of a hydrogenic impurity in the quantum well of a double heterostructure. An interaction gap is predicted between the bulk LO and TO frequencies, in contrast to the Frohlich-type interaction. These results are in good agreement with recent experimental data.
Author

N91-24914# Wayne State Univ., Detroit, MI. Dept. of Physics.
DOPING AND DIFFUSION IN HgCdTe Final Report, 15 Jun. 1987 - 30 Nov. 1990
C. G. Morgan-Pond 28 Jan. 1991 69 p
(Contract DAAL03-87-K-0061)
(AD-A232950; ARO-24837.11-MS) Avail: NTIS HC/MF A04 CSCL 07/2

The structural properties and electrical activity of impurities (indium, arsenic, antimony) and self-interstitials (mercury, cadmium, tellurium) in CdTe and HgCdTe alloys have been studied by theoretical and computer calculations. The problems addressed included: - the source of the midgap tunneling levels in Hg-rich HgCdTe, - the cause of electrical inactivity in In-doped CdTe grown by non-photoassisted molecular beam epitaxy (MBE), - identification of paths for impurity and self-diffusion, - the effects of lattice distortion on defect properties and interaction.
GRA

N91-24915# Research Triangle Inst., Research Triangle Park, NC.
SEMICONDUCTOR DIAMOND TECHNOLOGY Quarterly Report No. 3, 1 Jul. - 30 Sep. 1990
R. J. Markunas, R. A. Rudder, J. B. Posthill, and R. E. Thomas Mar. 1991 50 p
(Contract N00014-86-C-0460)
(AD-A233085; RTI/3629/90) Avail: NTIS HC/MF A03 CSCL 20/2

The progress is surveyed in a number of research activities pursued this quarter at Research Triangle Institute: Gas phase analysis in diamond producing charges; Determination of substrate effects on the growth of homoepitaxial diamond; F2/CH4 gas interactions as a function of temperature; Hydrogen-halogen exchange reactions; Fabrication and testing of a diamond IGFET; and investigation of LiF as an in-situ dopant for diamond. These parallel efforts are designed to advance the state-of-the-art in semiconducting diamond technology. These efforts are encompassing development of doping and fabrication techniques for diamond devices while they are also developing novel deposition technique targetting successful heteroepitaxial growth.
Author (GRA)

N91-24916# Cornell Univ., Ithaca, NY. School of Electrical Engineering.
ADVANCED TECHNOLOGY FOR IMPROVED QUANTUM DEVICE PROPERTIES USING HIGHLY STRAINED MATERIALS Technical Report, 15 Jun. - 15 Dec. 1989
William J. Schaff, S. D. Offsey, and Lester F. Eastman Mar. 1991 32 p
(Contract N00014-89-J-1386)
(AD-A233109) Avail: NTIS HC/MF A03 CSCL 20/12

Strained layer GaInAs/GaAs heterostructures for improved high frequency high performance as a result of strained modified valence band structure continue to be investigated. The first demonstration of improved microwave frequency bandwidths arose from increased differential gain for single strained quantum well structures. Optimized single quantum well growth is therefore undertaken to initiate the development of multiple quantum well lasers in 1990 to further increase differential gain. Properties of strained GaInAs on InP were also studied. A first attempt to grow and fabricate a laser on InP was successful, thus opening the opportunity to investigate strained lasers on InP. A first look into the theoretical properties of strained quantum wells has begun.
GRA

N91-24917# Westinghouse Defense and Electronic Systems Center, Baltimore, MD. Advanced Technology Div.
HIGH TEMPERATURE SUPERCONDUCTORS. WESTINGHOUSE SUPERCONDUCTING IR FOCAL PLANE ARRAY
Arthur S. Jensen Feb. 1991 2 p
(Contract SDIO84-88-C-0042)
(AD-A233229) Avail: NTIS HC/MF A01 CSCL 17/5

A brief statement of work to be performed is discussed: Conduct research on LTS circuits for IR detector arrays, Conduct research on HTS IR focal plane arrays, their construction and behavior, Demonstrate SC A/D circuit with photodiode signal current source, and Demonstrate the operation of an IR imaging system using SC A/D circuits.
GRA

N91-24918# General Electric Co., Schenectady, NY.
DEVELOPMENT OF ELEMENTS OF A HIGH T(SUB c) SUPERCONDUCTING CABLE Report, 1 Oct. - 31 Dec. 1990
Kenneth W. Lay 31 Dec. 1990 7 p
(Contract N00014-88-C-0681)
(AD-A233270) Avail: NTIS HC/MF A02 CSCL 20/12

The realigned program is aimed at the development of long lengths of silver-clad Bi2Sr2CaCuO(x,z) (BSCCO). A variation on the powder in tube technique will be used to make silver-clad BSCCO tapes. BSCCO-2223 is the material of choice with 20K the operating temperature goal. Such a tape conductor ultimately could be used in a coil for a magnet, motor or generator. A key element of the program is the development of processes with the potential of fabrication of very long conductors. A novel process for making silver clad tapes (SCT) is under study. In this process extruded BSCCO is wrapped with silver foil which is then pressure welded. This technique has the potential for fabrication of continuous lengths and also avoids the extensive size reduction and attending potential for non-homogeneity involved with the more conventional powder-in-tube (PIT) process. A parallel PIT study is also underway to use for comparison purposes and as a back-up process to the SCT process.
GRA

N91-24919# Research Triangle Inst., Research Triangle Park, NC.
SEMICONDUCTOR DIAMOND TECHNOLOGY Final Report, 1 Jan. - 31 Dec. 1990
R. J. Markunas, R. A. Rudder, J. B. Posthill, and R. E. Thomas Mar. 1991 65 p
(Contract N00014-86-C-0460)
(AD-A233293; RTI-83U-3629; RTI-3629-90) Avail: NTIS HC/MF A04 CSCL 20/2

This report summarizes results from the 1990 Semiconducting Diamond Technology Program. The advancement of existing technologies such as the low pressure rf-plasma assisted CVD technology has allowed the development of new techniques for diamond deposition. The research has emphasized growth

techniques for enhancing diamond heteronucleation. Highlights are listed below: Epitaxial lateral overgrowth was demonstrated; Diamond Schottky devices were fabricated with Li doping; Boron doped IGFETs were fabricated and tested; Gas analysis identified C2H2 by-product; Mo interlayers were deposited on Ni for heteronucleation studies; Hydrogen-halogen exchange reactions were demonstrated; A CF4/H2 system produced direct nucleation on Si(100); and Nucleation enhancement local to graphite fibers was demonstrated. GRA

N91-24920# Westinghouse Electric Corp., Pittsburgh, PA. Science and Technology Center.
SUPERCONDUCTING ELECTRONIC FILM STRUCTURES Final Report, 1 Jan. 1988 - 31 Dec. 1990
J. R. Gavaler and J. Talvacchio 14 Feb. 1991 211 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Contract F49620-88-C-0039)
(AD-A233473; Rept-91-9SL2-SUPER-R1; AFOSR-91-0207TR)
Avail: NTIS HC/MF A10 CSCL 20/3

The objective was to obtain both an understanding and control of superconducting and normal-state properties of layered, mostly epitaxial film structures incorporating high-critical-temperature oxide superconductors. Fulfillment is a step in the development of a technology base for superconducting electronics capable of operating above the temperature of 50 K, particularly for passive devices. The technology is based primarily on single-crystal YBCO films deposited by single-target sputtering. Based on a wide variety of characterization techniques, including tunneling and RF surface resistance, they are equal or superior to films made by any other method. Microwave devices fabricated with such films (in other programs at Westinghouse) showed markedly improved performance compared to conventional devices. The capability of sputtering YBCO films on large areas and on both sides of substrates was developed. State-of-the-art TBCCO and LSCO films were also prepared and evaluated. Procedures were developed for control of film orientation. Particular attention was given to film surfaces and interfaces with substrates, epitaxial buffer layers, and tunnel barriers. Specific results of the program are detailed in published papers appended to this report. GRA

N91-24921# Stanford Univ., CA.
JOINT SERVICES ELECTRONIC PROGRAM Annual Report, 1 Jun. 1989 - 30 Jun. 1990
James S. Harris, Jr. Mar. 1991 88 p
(Contract DAAL03-88-C-0011)
(AD-A233541) Avail: NTIS HC/MF A05 CSCL 09/1

Molecular Beam Epitaxy of High T Superconductors and Investigation of Quantum Well Structures; Physics and Applications of Ultra-Small, High Temperature Superconductors; Reactive Ion Profiling of Heterostructures; GaAs on Si Integrated Circuits; The Electronic Structure of High Temperature Superconductors; Semiconductor Laser with Ultra-Low Threshold Current; Device Physics and Technology of Silicon Based Heterostructures; MOS Devices Based on the GeSi1-x/Si Materials System; Combined Equalization and Coding; and Real-Time Statistical Signal Processing are discussed. GRA

N91-24922 Department of the Navy, Washington, DC.
METHOD OF PRODUCING YBa2Cu3O+x SUPERCONDUCTORS WITH HIGH TRANSITION TEMPERATURES Patent
A. S. Rao, inventor (to Navy), Om P. Arora, inventor (to Navy), and Louis F. Aprigliano, inventor (to Navy) 8 Jan. 1991 4 p Filed 30 Jan. 1990
(AD-D014836; US-Patent-4,983,571; US-Patent-Appl-SN-472008; US-Patent-Class-501-1) Avail: US Patent and Trademark Office CSCL 09/1

A method for improving the superconducting transition temperature of the MBA2Cu3Ox, where M is selected from the group consisting of Y, Er, Eu, Yb, Dy and Ho and where x is a value of from 6 to 7 ceramic. The use of specific sequences of heat treating times and temperatures in conjunction with the use of silver oxide in making superconducting devices or wires is examined. Ultimate uses are in motors, generators and electrical circuits. GRA

N91-24923# Department of Energy, Washington, DC.
INSTALLATION OF SEMICONDUCTOR CRYSTAL GROWTH AND PROCESSING FACILITIES IN THE BUILDING 166 ADDITION AT LAWRENCE LIVERMORE NATIONAL LABORATORY
Aug. 1990 40 p
(DE91-010254; DOE/EA-0431) Avail: NTIS HC/MF A03

A new addition was constructed to Building 166 at Lawrence Livermore National Laboratory (LLNL). This addition is intended to contain facilities as described below. The Metalorganic Chemical Vapor Deposition (MOCVD) facility is a proposed facility for the growth of semiconductor crystals composed of various combinations of gallium, aluminum, indium, arsenic, phosphorous, antimony, silicon, and zinc. This facility will utilize hazardous metal hydride gases (arsine, silane, and disilane) and pyrophoric materials (metal alkyls). The MOCVD process has been intensively developed over the past 10 years and is being safely utilized in over 75 locations worldwide in both research and manufacturing applications. All equipment in the LLNL MOCVD facility is commercially available and is typical of that used in similar facilities in both industry and academia. The Semiconductor Device Fabrication (SDF) facility is a proposed facility for the fabrication of semiconductor devices from crystals grown in the MOCVD facility. General laboratory chemicals and silane gas will be utilized in this facility. The remaining space in the building addition will consist of an optics laboratory and general purpose work area. The only hazardous materials to be used in these areas are small quantities of common laboratory solvents. For the purposes of this Environmental Assessment, these areas will be considered to be part of the SDF. DOE

N91-24924# Argonne National Lab., IL.
THERMODYNAMIC BEHAVIOR OF HIGH-T(SUB c) OXIDE SYSTEMS VIA EMF AND RELATED MEASUREMENTS
M. Tetenbaum, P. J. Tumidajski, D. L. Brown, and M. Blander 1991 7 p Presented at the 2nd International Conference on Rare Earth Development and Applications, Beijing (China), May 1991
(Contract W-31-109-eng-38)
(DE91-010589; ANL/CP-71426; CONF-9105154-1) Avail: NTIS HC/MF A02

EMF measurements of oxygen fugacities as function of stoichiometry were made in the YBa2Cu3O(x), NdBa2Cu3O(x), and Nd(1.81)Ce(0.19)CuO(x) superconducting systems in the temperature range 400 to 750 C by means of an oxygen titration technique with an yttria stabilized zirconia electrolyte. The object of the current measurements is to investigate the effect of ionic size of Y, Gd and Nd on immiscibility and other structural transitions in the LnBa2Cu3O(x) system. The shape of the 400 C isotherm for NdBa2Cu3O(x) indicates that, if a miscibility gap is present, it exists at lower temperatures and at values of x that are higher than those for the miscibility gap deduced in the YBa2Cu3O(x) system. The relative locations of the miscibility gap are consistent with the effects of ionic radii on the composition dependence of (Tc) for these systems. The results explain the two plateaus in measured values of (Tc) as a function of composition for the YBa2Cu3O(x) system and appear to be consistent with the less pronounced (Tc) plateau found for the NdBa2Cu3O(x) system at higher values of stoichiometry. For a given oxygen stoichiometry, partial pressures of oxygen above NdBa2Cu3O(x) are higher than for the YBa2Cu3O(x) system. Results of limited measurements on the n-type (electron doped) superconducting Nd(1.81)Ce(0.19)-CuO(x) system is presented. DOE

N91-24925# Argonne National Lab., IL. Mathematics and Computer Science Div.
MATHEMATICAL MODELS OF SUPERCONDUCTIVITY
H. G. Kaper Mar. 1991 21 p

(Contract W-31-109-eng-38)
(DE91-010827; ANL/MCS-TM-146) Avail: NTIS HC/MF A03

This note surveys some mathematical models that have been proposed to study the phenomenon of superconductivity. The following subject areas are covered: facts from physics, the London model, Pippard's modification of the London model; and the Ginzburg-Landau model. DOE

N91-24926# International Centre for Theoretical Physics, Trieste (Italy).
ELASTIC CONSTANTS OF THE HARD DISC SYSTEM IN THE SELF-CONSISTENT FREE VOLUME APPROXIMATION
K. W. Wojciechowski Sep. 1990 13 p
(DE91-617800; IC-90/281) Avail: NTIS HC/MF A03

Elastic moduli of the two dimensional hard disc crystal are determined exactly within the Kirkwood self-consistent free volume approximation and compared with the Monte Carlo simulation results. DOE

N91-24927# Melbourne Univ., Parkville (Australia). School of Physics.
FRACTAL ANALYSIS OF CRYSTALLINE SURFACES AT ATOMIC RESOLUTION
L. A. Bursill, Xudong Fan, and Julin Peng 1990 34 p
(DE91-617803; UM-P-90/59) Avail: NTIS HC/MF A03

High-resolution images of ceramic oxide surfaces (MgO, NiO, and BaTiO3) have been obtained in digitized form. Analytical techniques were designed to search for self-similar scaling (fractal) geometries. Three measures of surface roughness were investigated: coastline analysis, height-difference correlation function analysis, and variance scaling analysis. In some cases, changes in surface topology occur with time. In principle, this should be analyzed using self-affine fractal geometry and scaling concepts. The scaling behavior was in all cases complicated by atomic surface facetting. Analytical results are reported for all crystalline surfaces imaged. The results are interpreted in terms of Brownian motion or self-diffusion and Brownian motion with geometrical restriction (lattice string animal models). DOE

N91-24928# International Centre for Theoretical Physics, Trieste (Italy).
SUPERCONDUCTIVITY IN DOPED ANTIFERROMAGNETS
M. Lagos Sep. 1990 15 p
(DE91-618100; IC-90/284) Avail: NTIS HC/MF A03

The antiferromagnetic S = 1/2 Heisenberg model is extended to account for the presence of holes. The holes move along a sublattice whose sites are located in between the spin sites. The spin-hole coupling arises from the modification of the exchange interaction between two neighboring spins when the site between them is occupied by a hole. This physical picture leads to a generalized version of the so called t-J model Hamiltonian. The use of a recently developed method that introduces spin-O excitations for dealing with the Heisenberg antiferromagnetic model allows us to map the model Hamiltonian onto a Froelich one, with the spin-O magnetic excitations substituting phonons. The case of electrons moving along the spin sites is discussed as well. DOE

N91-24929# Melbourne Univ., Parkville (Australia). School of Physics.
PRECISION CRYSTAL ALIGNMENT FOR HIGH-RESOLUTION ELECTRON MICROSCOPE IMAGING
G. J. Wood and M. J. Beeching 1990 22 p
(DE91-619397; UM-P-90/56) Avail: NTIS HC/MF A03

One of the more difficult tasks involved in obtaining quality high-resolution electron micrographs is the precise alignment of a specimen into the required zone. The current accepted procedure, which involves changing to diffraction mode and searching for a symmetric point diffraction pattern, is insensitive to small amounts of misalignment and at best qualitative. On-line analysis of the Fourier space representation of the image, both for determining and correcting crystal tilt, is investigated. DOE

N91-24930# Northwestern Univ., Evanston, IL. Dept. of Materials Science and Engineering.
DEFECT STRUCTURE OF SEMICONDUCTING AND INSULATING EPITAXIAL OXIDES, MAY 1, 1990 - APRIL 30, 1991
B. W. Wessels 1991 4 p
(Contract DE-FG02-85ER-45209)
(DE91-010640; DOE/ER-45209/5) Avail: NTIS HC/MF A01

SrTiO3 thin films were deposited by low-pressure organometallic chemical vapor deposition. Titanium isopropoxide, Sr(dipivaloylmethanate)2, oxygen, and water vapor were used as reactants, and argon was used as a carrier gas. Growth rates ranging from 0.3 to 4.5 micron/h were obtained on (0001) sapphire substrates at 600 to 850 C. Highly textured SrTiO3 films with a zone axes (111) orientation were obtained at a growth temperature of 800 C. The growth parameters which influenced the composition, phase stability, morphology, and texture of the thin films were examined. In addition to the SrTiO3, bismuth titanate film deposition and their properties were investigated. As in the case of strontium titanate, bismuth titanate is a semiconducting ferroelectric with perovskite-related structures. A number of phases can be stabilized in the bismuth titanate system. The compound Bi4Ti3O12 has been previously examined for its potential as a dielectric or optical material. The Curie temperature for this compound is 675 C. DOE

N91-25093*# Technical Univ. of Denmark, Lyngby. Physics Lab.
RESULTS OF THE TTF-TCNQ- AND THE CALCIUM CARBONATE-CRYSTALLIZATION ON THE LONG DURATION EXPOSURE FACILITY Abstract Only
Kjeld Flemming Nielsen and M. David Lind (Rockwell International Science Center, Thousand Oaks, CA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 128 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20L

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

N91-24931# Melbourne Univ., Parkville (Australia). School of Physics.
ENTROPY OF RANDOM QUANTUM STATES
R. W. Jones Oct. 1990 5 p Submitted for publication
(DE91-617585; UM-P-90/89) Avail: NTIS HC/MF A01

A simple generating function was used to calculate exactly the entropy of random quantum states for finite-dimensional Hilbert spaces over real, complex and quaternionic scalars. This allows to extend the previous formula for the Quantum Correlation Information of a state determination apparatus to include real and quaternionic von Neumann analysers. DOE

N91-24932# Melbourne Univ., Parkville (Australia). School of Physics.
INCLUSION OF SHORT-RANGE ORDER IN A MEAN FIELD THEORY FOR THE DISORDERED MAGNETIC LATTICE GAS
T. Taucher and N. E. Frankel 1990 27 p Submitted for publication
(DE91-617804; UM-P-90/61) Avail: NTIS HC/MF A03

The disordered magnetic lattice gas (DMLG) as a unifying description of many simpler random spin systems has been investigated in an attempt to devise a mean field theory which goes beyond the infinitely long-ranged model by incorporating short-range order. It is shown that rigorously the local thermodynamic properties of the DMLG on a Cayley tree of finite coordination number z are identical to the thermodynamic

properties of the DMLG in a pair approximation obtained by using the method of the distribution function. Furthermore, a modified pair approximation for the DMLG is presented which is exactly solvable. It is formulated for general random bond distribution functions, and is then examined for the special case of Gaussian distributions. DOE

N91-24933*# Fermi National Accelerator Lab., Batavia, IL.
INVESTIGATING DECOHERENCE IN A SIMPLE SYSTEM
Andreas Albrecht 17 May 1991 53 p
(Grant NAGw-1340)
(NASA-CR-188450; NAS 1.26:188450; FERMILAB-Pub-91/101-A)
Avail: NTIS HC/MF A04 CSCL 20C

The results of some simple calculations designed to study quantum decoherence are presented. The physics of quantum decoherence are briefly reviewed, and a very simple 'toy' model is analyzed. Exact solutions are found using numerical techniques. The type of incoherence exhibited by the model can be changed by varying a coupling strength. The author explains why the conventional approach to studying decoherence by checking the diagonality of the density matrix is not always adequate. Two other approaches, the decoherence functional and the Schmidt paths approach, are applied to the toy model and contrasted to each other. Possible problems with each are discussed. Author

N91-24934*# Fermi National Accelerator Lab., Batavia, IL.
PLAUSIBLE DOUBLE INFLATION
Richard Holman, Edward W. Kolb, Sharon L. Vadas, and Yun Wang (Carnegie-Mellon Univ., Pittsburgh, PA.) Mar. 1991 12 p
(Contract NAGw-1340; DE-AC02-76ER-03066)
(NASA-CR-188449; NAS 1.26:188449; FNAL-PUB-91/80-A; CMU-HEP91-05) Avail: NTIS HC/MF A03 CSCL 20C

It is likely that extended inflation is followed by an epoch of slowroll inflation. Such a sequence of events may lead to a very interesting perturbation spectrum with significant power on the scale of the transition between the extended and slowroll phase, superimposed upon a power-law spectrum with deviations from the Harrison-Zeldovich slope. Normalization of the spectra above and below the transition scale is expected to differ. Author

80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

N91-24089# Wichita State Univ., KS. National Inst. for Aviation Research.
ADDITIONAL SECONDARY CERTIFICATION IN AEROSPACE EDUCATION FOR KANSAS EDUCATORS
Brent D. Bowen and Robert Kuhns *In its* Kansas Aviation Review 1991 p 9-13 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

N91-24092# Wichita State Univ., KS. National Inst. for Aviation Research.
DEMAND ESTIMATION FOR COLLEGIATE AVIATION ACADEMIC PROGRAMS
Phillips W. Goodell *In its* Kansas Aviation Review 1991 p 30-38 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

N91-24935# Ministry of Defence, Haifa (Israel). Center for Military Analyses.
THE OPTIMAL ACCUMULATION OF POWER
Ilan Amit and Ariel Halperin Dec. 1987 57 p
(CEMA-87-87; ITN-90-85016) Copyright Avail: NTIS HC/MF A04

Power is defined as a depreciable, non-consumable commodity, produced by capital and labor. Its optimal accumulation over time requires the allocation of resources between investment, consumption and power. Assuming consumption to be a fixed share of the product, the best policy for the indefinite future is to follow a balanced growth, after an initial adaptation phase. A similar policy is optimal for consumption vs. investment, when the level of allocation to power is kept fixed. It turns out that both policies have always a common point (i.e., a set of allocation levels), which under broad conditions is unique. This point is a stable Nash equilibrium compromise between power and welfare, or consumption, in the sense explained in the sequel. It may be regarded as a good candidate for an overall social policy without postulating a global social utility. When two societies engage in a rivalry over power, then the optimal unilateral accumulation policies constitute a Nash equilibrium for the bilateral case. This indicates that the social compromise suggested above may be valid even when an external conflict prevails. ISA

N91-24936* National Aeronautics and Space Administration, Washington, DC.
MANAGEMENT: A BIBLIOGRAPHY FOR NASA MANAGERS
Mar. 1991 195 p
(NASA-SP-7500(25); NAS 1.21:7500(25)) Avail: NTIS HC A09 CSCL 05B

This bibliography lists 731 reports, articles and other documents introduced into the NASA Scientific and Technical Information System in 1990. Items are selected and grouped according to their usefulness to the manager as manager. Citations are grouped into ten subject categories: human factors and personnel issues; management theory and techniques; industrial management and manufacturing; robotics and expert systems; computers and information management; research and development; economics, costs and markets; logistics and operations management; reliability and quality control; and legality, legislation, and policy. Author

N91-24937# Naval Postgraduate School, Monterey, CA.
A PRACTICABILITY STUDY ON THE DEVELOPMENT OF A STANDARD, STAND-ALONE COMPUTERIZED CONTRACT PRICING MODEL FOR CONTRACT PRICING AND NEGOTIATIONS M.S. Thesis
Jonathan L. Katz Jun. 1990 122 p
(AD-A232012) Avail: NTIS HC/MF A06 CSCL 05/1

The practicability is examined of developing a standard, stand-alone, computerized contract pricing model for contract pricing and negotiations. A functional description of a proposed framework for a standard, stand-alone. computerized contract pricing model is provided. The results of data collected from a survey of DLA, Navy, and Marine Corps field contracting activities are examined and the practicability of developing such a model is analyzed. GRA

N91-24938# Naval Postgraduate School, Monterey, CA. Dept. of Administrative Sciences.
LEARNING CURVE AND RATE ADJUSTMENT MODELS: AN INVESTIGATION OF BIAS
O. D. Moses Feb. 1991 58 p
(AD-A233115; NPS-AS-91-005) Avail: NTIS HC/MF A04 CSCL 05/1

Learning curve models have gained widespread acceptance as a technique for analyzing and forecasting the cost of item produced from a repetitive process. Considerable research has investigated augmenting the traditional learning curve model with the addition of a production rate variable, creating a rate adjustment model. The forecasting bias is compared of the learning curve and rate adjustment models. A simulation methodology is used to vary conditions along seven dimensions. The magnitude and direction of errors in future cost estimates are analyzed and compared under the various simulated conditions, using ANOVA. Overall results indicate that the rate adjustment model is generally unbiased. If the cost item being forecast contains any element

that is not subject to learning them the traditional learning curve model is consistently biased toward underestimation of future cost. Conditions when the bias is strongest are identified. GRA

82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

N91-24939*# National Aeronautics and Space Administration, Washington, DC.
NASA SCIENTIFIC AND TECHNICAL PUBLICATIONS: A CATALOG OF SPECIAL PUBLICATIONS, REFERENCE PUBLICATIONS, CONFERENCE PUBLICATIONS, AND TECHNICAL PAPERS, 1987-1990
Feb. 1991 174 p
(NASA-SP-7063(05); NAS 1.21:7063(05)) Avail: NTIS HC free as PR-890; NASA Center for AeroSpace Information, BWI Airport, MD free CSCL 05B

This catalog lists 783 citations of all NASA Special Publications, NASA Reference Publications, NASA Conference Publications, and NASA Technical Papers that were entered into the NASA Scientific and Technical Information Database during the accession years 1987 through 1990. The entries are grouped by subject category. Indexes of subject terms, personal authors, and NASA report numbers are provided. Author

N91-24940 Minnesota Univ., Minneapolis.
MULTILEVEL SECURE DATABASE MANAGEMENT SYSTEMS Ph.D. Thesis
Thomas Fredrick Keefe 1990 298 p
Avail: Univ. Microfilms Order No. DA9107435

Security models are discussed for object oriented Database Management Systems (DBMSs) along with concurrency control for DBMSs in general. A framework is described for classifying security models for object oriented systems in terms of authorization basis, classification granularity and intersubject cooperation and it is used to classify several security models proposed for object oriented DBMSs. This framework is used to study security, programming languages, and DBMS design issues. A security model is proposed for a multilevel Secure Object oriented DAtabase (SODA) and several security properties are shown of the model including the simple security condition and the *-property. The model is characterized in terms of the framework. An exploratory prototype of the model was built. The design of the prototype is discussed and the experience in building it is described. Security issues involved in database concurrency control for Multilevel Secure DBMSs are examined. Secure systems are characterized in terms of several levels of assurance and it is shown how a scheduler can affect the security of the system in this framework. A concept of Data Conflict Security is introduced and explained. Dissert. Abstr.

N91-24941 Texas Univ., Austin.
QUERY PERFORMANCE ENHANCEMENT TECHNIQUES IN OBJECT-ORIENTED DATABASES Ph.D. Thesis
Kyung Chang Kim 1990 313 p
Avail: Univ. Microfilms Order No. DA9105585

An underlying query graph model is proposed for object oriented data bases, and three techniques are examined that can be used to enhance query performance. To make concrete the query model, a class of queries are identified which are to be examined, and any query which can be expressed in ORION object oriented query language is then transformed into its query graph model. Given the query model, how access plans are generated is discussed and graph transversal methods and alternative query evaluation algorithms are identified. The first proposed query performance enhancement technique is an indexing technique for object oriented data bases. The techniques are influenced by the fundamental object oriented constructs. The next query performance enhancement technique proposed is query optimization. Query optimization heuristics are proposed to limit the number of access plans to be evaluated for possible execution. And the third technique proposed is parallelism. Situations are identified in which parallelism can be exploited in the query graph model. Dissert. Abstr.

N91-24942 Research Libraries Group, Inc., Mountain View, CA.
INFORMATION NEEDS IN THE SCIENCES: AN ASSESSMENT
Constance C. Gould and Karla Pearce Mar. 1991 85 p
Copyright Avail: Issuing Activity

This assessment of information needs in eight science disciplines was produced to guide the activities of the Research Libraries Group's Program for Research Information Management. The purpose of this assessment is to obtain a broad view of the shape of each discipline and to illuminate the relationship between these trends and the data requirements of the discipline. Disciplines included are physics, chemistry, biology, geosciences, astronomy, engineering, mathematics, and computer science. Author

N91-24943*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA/DOD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT. FACULTY AND STUDENT RESPONDENTS Summary Report No. 8
Thomas E. Pinelli, John M. Kennedy, and Terry F. White (Indiana Univ., Bloomington.) Jun. 1991 9 p
(NASA-TM-104085; NAS 1.15:104085) Avail: NTIS HC/MF A02 CSCL 05B

Phase 3 of a four part study was undertaken to investigate the use of scientific and technical information (STI) in the academic aerospace community. Three questionnaires that were sent to three groups (i.e., faculty, librarians, and students) in the academic aerospace community were used. Specific attention was paid to the types of STI used and the methods in which academic users acquired STI. The focus is on the responses of two of the three groups: faculty in aerospace departments and students enrolled in the USRA-funded capstone design courses. Respondents in both groups relied heavily upon informal sources of information, although students were less inclined to regard their personal collections of STI as important. Both groups relied upon most formal sources of STI about the same, but students reported more difficulty in using the formal resources. Author

N91-24944# Office of Management and Budget, Washington, DC.
CURRENT INFORMATION TECHNOLOGY RESOURCE REQUIREMENTS OF THE FEDERAL GOVERNMENT: FISCAL YEAR 1991
Jan. 1991 316 p
(PB91-151894) Avail: NTIS HC/MF A14; also available SOD HC $16.00 as 041-001-00348-7 CSCL 05B

A compilation is given of individual Federal agency information technology acquisition plans for the fiscal years 1990 through 1995. It should be noted that the resources data contained in the document is subject to change and was prepared prior to the enactment of FY 1991 appropriations. Further, the lists of specific acquisition plans represent agencies' best estimates of what they intend to acquire and how they plan to acquire it, given current budget estimates. Dissert. Abstr.

N91-24945# National Technical Information Service, Springfield, VA.
NTIS BIBLIOGRAPHIC DATABASE USER'S GUIDE FOR FINAL ISSUE TAPE FORMAT AND IA-EDIT INTERNAL TAPE FORMAT (REVISED)
A. M. Barney and T. L. Brookshire 10 Jan. 1991 109 p
(PB91-149500-Rev) Avail: NTIS HC/MF A06 CSCL 05B

The guide defines the ADP file format of the National Technical Information Service (NTIS) final issue tape format and the IA-EDIT internal tape format. It includes brief descriptions and examples

of data in each field of the file. The document should be used in conjunction with the Guidelines for Descriptive Cataloging of Reports, 1985. The guide is intended primarily for ADP persons who need to know the detail and format for programming. The NTIS final issue tape format holds bibliographic data used to announce specialized technical information in the Government Reports Announcements and Index (GRA and I). The bimonthly NTIS journal describes reports, journal articles, data files, software, and U.S. Government owned inventions. The NTIS final issue tape file is used to edit and publish the GRA and I and abstract newsletters, and is itself leased by many NTIS customers, such as, DIALOG, BRS, NERAC, etc.. Most logical records for a document have 2 or 3 physical 1024 character blocks. The forty-two data fields begin with a 2 or 3 character tag and end with a cent sign (terminator/delimiter). The NTIS final issue format is similar to the NTIS IA-EDIT internal tape format. The IA-EDIT format lacks the data field tags, and is not available for customers. It is used internally by NTIS, and some agencies submit their data to NTIS in this format for announcement in GRA and I, etc. GRA

N91-24946# California Univ., Los Angeles.
DESIGNING A HYPERCARD DATABASE FOR THE NATURAL LANGUAGE SOURCEBOOK Technical Report, 1 Feb. 1989 - 30 Sep. 1990
Howard Herl Sep. 1990 25 p
(Contract N00014-86-K-0395)
(AD-A232946) Avail: NTIS HC/MF A03 CSCL 12/7

The UCLA Center for Technology Assessment of the Center of the Study of Evaluation has an existing contract with the Defense Advance Research Projects Agency to study human benchmarking methodology for the evaluation of artificial intelligence systems. Systems of interest include vision, natural language, experts systems shells and expert systems. The implementation is documented of the Natural Language Sourcebook hardcopy document to a user friendly, interactive HyperCard database stack. The two primary tasks of the project were: (1) Specifying system components, and (2) Designing and developing the Sourcebook database. The tasks of the project are described in the following sections: Section 1, Specification of System Components, provides a description of the content in the Natural Language Sourcebook which is included in the electronic version of the Sourcebook database; Section 2, Design and Development of the Sourcebook Database, describes the overall design and documentation of the development of the HyperCard stack for the Sourcebook database and the accompanying user's manual. GRA

N91-24947# Air Force Environmental Technical Applications Center, Scott AFB, IL.
GLOSSARY OF AWS ACRINABS: ACRONYMS, INITIALISMS, AND ABBREVIATIONS COMMONLY USED IN AIR WEATHER SERVICE
George M. Horn Jan. 1991 60 p
(AD-A233009; USAFETAC/TN-91/001) Avail: NTIS HC/MF A04 CSCL 04/2

This report consists of a collection of acrinabs (acronyms, initialisms, and abbreviations) commonly used in the Air Force Air Weather Service. The acrinabs in this listing have been collected from a number of technical publications, journals, directives, and other glossaries. The collection is intended for use as a decoding device and should not be considered an authoritative source to spelling, exact meaning or usage. GRA

N91-24948# Georgia Univ., Athens. Complex Carbohydrate Research Center.
CARBBANK AND THE COMPLEX CARBOHYDRATE STRUCTURE DATABASE
P. Albersheim Feb. 1991 228 p
(Contract DE-FG09-88ER-13970)
(DE91-009872; DOE/ER-13970/5) Avail: NTIS HC/MF A11

The Complex Carbohydrate Structure Database (CCSD), an IBM PC-compatible computerized database, and CarbBank, the database management system were created to provide a structure and citation information system to meet the needs of persons interested in complex carbohydrates. CCSD and CarbBank, which were initiated by an international body of carbohydrate scientists, have been in development since 1986 and have been commercially available since 1989. It is proposed to continue developing CarbBank-associated software, to continue building the CCSD, and to make the software available as part of larger database efforts administrated by the National Center for Biotechnology Information (NCBI) and by Chemical Abstracts Service (CAS). A completely open format will be created for the CCSD and portable, well documented program modules that will ultimately be available to academic and commercial groups interested in creating computer programs that access CCSD data. The CCSD and CarbBank will also be made compatible with several additional computer environments. The CCSD is expected to grow from its present 3888 records to over 20,000 records. It is the goal to ensure that CarbBank plays a key role in managing carbohydrate structure information in the global biotechnology arena. DOE

N91-24949# Sandia National Labs., Albuquerque, NM.
TRANSNET: A MEANS OF ACCESSING HAZARDOUS MATERIALS TRANSPORTATION MODELS AND DATABASES
J. W. Cashwell 1991 9 p Presented at the Waste Management 1991, Tucson, 24-28 Feb. 1991
(Contract DE-AC04-76DP-00789)
(DE91-009980; SAND-91-0611C; CONF-910270-37; TTC-1077)
Avail: NTIS HC/MF A02

TRANSNET is a compilation of risk and systems analysis codes, routing and cost models and related data that address hazardous and radioactive materials transportation. TRANSNET is the acronym assigned to this system of models and associated data which reside on a dedicated MicroVAX 3800. After obtaining a password, users may access TRANSNET with a modem-equipped personal computer. TRANSNET was developed by Sandia National Laboratories (SNL) under the sponsorship of the United States Department of Energy (DOE) Office of Defense Programs (subsequently reorganized to the Office of Environmental Restoration and Waste Management). The goals of the TRANSNET system are to speed transfer of technology and data to qualified users by permitting access to the most comprehensive and up-to-date transportation risk and systems analysis models and associated databases. DOE

N91-24950# Oak Ridge National Lab., TN.
JANE: A NEW INFORMATION RETRIEVAL SYSTEM FOR THE RADIATION SHIELDING INFORMATION CENTER
D. K. Trubey May 1991 89 p
(Contract DE-AC05-84OR-21400)
(DE91-010785; ORNL/RSIC-53) Avail: NTIS HC/MF A05

A new information storage and retrieval system has been developed for the Radiation Shielding Information Center (RSIC) at Oak Ridge National Laboratory to replace mainframe systems that have become obsolete. The database contains citations and abstracts of literature which were selected by RSIC analysts and indexed with terms from a controlled vocabulary. The database, begun in 1963, has been maintained continuously since that time. The new system, called JANE, incorporates automatic indexing techniques and on-line retrieval using the RSIC Data General Eclipse MV/4000 minicomputer, Automatic indexing and retrieval techniques based on fuzzy-set theory allow the presentation of results in order of Retrieval Status Value. The fuzzy-set membership function depends on term frequency in the titles and abstracts and on Term Discrimination Values which indicate the resolving power of the individual terms. These values are determined by the Cover Coefficient method. The use of a commercial database base to store and retrieve the indexing information permits rapid retrieval of the stored documents. Comparisons of the new and presently-used systems for actual searches of the literature indicate that it is practical to replace the mainframe systems with a minicomputer system similar to the present version of JANE.
DOE

N91-24951*# National Aeronautics and Space Administration, Washington, DC.
QUO VADIMUS: COMING TO GRIPS WITH THE INFORMATION WORLD
Walter R. Blados May 1991 10 p
(NASA-TM-105138; NAS 1.15:105138) Avail: NTIS HC/MF A02 CSCL 05B

The new information-oriented culture in which we find ourselves has created new relationships, new stimulating and expanding opportunities, new methods of doing our work, and new environments in which we carry out our work. An integral part of the NASA aerospace research and development (R and D) process is the scientific and technical information (STI) associated with it; it is both a raw material (input) and a product (output) of this process. Within this process, the NASA STI Program is tasked to provide information management and services, to ensure that accurate and timely STI is generated and entered into an appropriate information service and made available in a usable form to those who have a need for it; in essence, a means to exploit both internal (NASA corporate) and pertinent external (other governmental/industrial/foreign) information to meet the requirements of the R and D community. To understand the STI Program management issues, it is critical to understand the role of the STI Program in the context of the R and D process. STI management must become part of the accepted culture of the R and D community, but it cannot become so unless adopted and accepted by it. A start should be made now to integrate the NASA STI Program into the R and D infrastructure, including funding and operational control. Within this infrastructure, we must obtain management commitment, review and produce policy reflecting the organizational status, allocate responsibilities, and set to work on implementing the true requirements of the R and D community. Author

N91-24091# Wichita State Univ., KS. Ablah Library.
AN OVERVIEW OF INFORMATION RESOURCES IN AVIATION
Thomas G. DePetro *In its* Kansas Aviation Review 1991 p 21-29 (For primary document see N91-24087 16-01)
Avail: NTIS HC/MF A03

83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

N91-24952*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
BALANCING RELIABILITY AND COST TO CHOOSE THE BEST POWER SUBSYSTEM
Ronald C. Suich (California State Univ., Fullerton.) and Richard L. Patterson 1991 7 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by the American Nuclear Society, SAE, the American Chemical Society, AIAA, ASME, IEE, and the American Inst. of Chemical Engineers
(Grant NAG3-1100)
(NASA-TM-104453; E-6294; NAS 1.15:104453) Avail: NTIS HC/MF A02 CSCL 05C

A mathematical model is presented for computing total (spacecraft) subsystem cost including both the basic subsystem cost and the expected cost due to the failure of the subsystem. This model is then used to determine power subsystem cost as a function of reliability and redundancy. Minimum cost and maximum reliability and/or redundancy are not generally equivalent. Two example cases are presented. One is a small satellite, and the other is an interplanetary spacecraft. Author

84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

No abstracts in this category.

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

N91-24953# California Univ., Los Angeles.
PERSPECTIVES ON TECHNOLOGY ASSESSMENT Interim Report, 1 Jul. 1990 - 31 Jan. 1991
Eva L. Baker, Frances A. Butler, and Harold F. ONeil, Jr. 1991 397 p
(Contract N00014-86-K-0395; NR Proj. RR0-4206)
(AD-A232918) Avail: NTIS HC/MF A17 CSCL 05/2

This collection of technical papers represents an expansion of ideas presented at the conference 'Technology Assessment: Estimating the Future' held at UCLA on September 5 and 6, 1990. The goal for the conference was to identify the major strategies and most promising practices for assessing technology. The papers present perspectives from computer science, cognitive and military psychology, and education. The authors, representing government, business, and university sectors, help to set the boundaries of present technology assessment practices. The papers are organized into three groups: Models and Syntheses, Assessment of Software Strategies, and Examples of Training and Assessment Technologies. The groups reflect the specific emphases and research interests of the authors within the broad area of technology assessment. GRA

N91-24954# California Univ., Los Angeles.
PROCEEDINGS OF THE CONFERENCE ON TECHNOLOGY ASSESSMENT: ESTIMATING THE FUTURE Report, 1 Mar. - 30 Sep. 1990
Eva L. Baker, Frances A. Butler, and Harold F. ONeil, Jr. 1990 19 p Conference held in Los Angeles, CA, 5-6 Sep. 1990
(Contract N00014-86-K-0395)
(AD-A233528) Avail: NTIS HC/MF A03 CSCL 12/5

This document provides the agenda and set of abstracts for the Conference on Technology Assessment: Estimating the Future, held at UCLA, September 5 to 6, 1990. GRA

N91-24955# Pacific Northwest Lab., Richland, WA.
TECHNOLOGY TRANSFER QUALITY ASSURANCE
F. C. Hood Mar. 1991 7 p Presented at the 2nd International Waste Management Conference, Las Vegas, 17-20 Mar. 1991
(Contract DE-AC06-76RL-01830)
(DE91-010009; PNL-SA-19240; CONF-910384-1) Avail: NTIS HC/MF A02

The results of research conducted at Pacific Northwest Laboratory (PNL) for the DOE are regularly transferred from the laboratory to the private sector. The principal focus of PNL is on environmental research and waste management technology; other programs of emphasis include molecular science research. The technology transfer process is predicated on Quality to achieve its objectives effectively. Total quality management (TQM) concepts and principles readily apply to the development and translation of new scientific concepts into commercial products. The concept of

technology transfer epitomizes the TQM tenet of continuous improvement: always striving for a better way to do things and always satisfying the customer. A successful technology transfer process adds value to society by providing new or enhanced processes, products, and services to government and commercial customers, with a guarantee of product pedigree and process validity. DOE

N91-24956# Sandia National Labs., Albuquerque, NM.
TECHNOLOGY TEAMWORK: THE ROLE OF THE NATIONAL LABORATORIES IN IMPLEMENTING US TECHNOLOGY POLICY
A. Narath, G. Yonas, and B. C. Dale Mar. 1991 8 p
(Contract DE-AC04-76DP-00789)
(DE91-010017; SAND-91-0408) Avail: NTIS HC/MF A02

In September 1990, the President's Office of Science and Technology released a document that bears on the future of our nation's technological vigor and economic performance. Entitled, U.S. Technology Policy, it is a statement of a set of broad principles that will constitute the Federal government's technology policy for the 1990s. One of the leading principles of this policy is the imperative for cooperation and teamwork among government, industry, and academia, including an active, partnership role for the national laboratories in the mainstream U.S. technology community. Until now, the nation's technology policy has never been explicit, although a tacit technology policy of one sort or another has at all times been in effect. The Federal government has consistently been willing to create and fund institutions and programs to promote important national technology goals. Historical examples of such sponsorship include atomic energy, agriculture, aeronautics and space, energy, and medicine. The recognition in U.S. Technology Policy that government has an active role to play in fostering technology development is a particularly significant admission. The vision of a partnership between the Federal government and the private sector, as the policy outlines, provides a foundation upon which the national laboratories of the Department of Energy (DOE) can build to play a stronger role in enhancing U.S. economic competitiveness. DOE

88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

N91-24957 Georgia State Univ., Atlanta.
THE TIME SCALES OF THE OPTICAL VARIABILITY OF BLAZARS Ph.D. Thesis
Michael Thomas Carini 1990 191 p
Avail: Univ. Microfilms Order No. DA9101931

Observations were obtained of a subset of the class of active galactic nuclei known as blazars in order to determine if microvariability exists in these objects. These observations were obtained with CCD detectors used in an N-star photometer mode. For the first time, the existence of rapid variations within a given night, or microvariability, was conclusively established in blazars. The typical rate of change in these variations was found to be 0.01 mag/hour. Such variations were determined to be a general characteristic of this class of objects. If one adopts a model involving accretion into a supermassive black hole, a calculation of a characteristic timescale from the variations can be used to estimate certain physical parameters associated with the supermassive black holes believed to be at the center of these objects. The observations were found to be consistent with the hypothesis that at the center of these objects there exists a geometrically thick accretion disk surrounding a supermassive black hole. A power spectrum analysis of the variations was performed and yielded two important results, which are briefly discussed. Dissert. Abstr.

N91-24958 Cornell Univ., Ithaca, NY.
VOYAGER INFRARED OBSERVATIONS OF THE OUTER SOLAR SYSTEM Ph.D. Thesis
Andrew Livingstone Weir 1990 140 p
Avail: Univ. Microfilms Order No. DA9106251

During the Voyager 1 and 2 encounters with Jupiter and Neptune, global mapping sequences were obtained by the Infrared Interferometer Spectrometer (IRIS). Previously performed inversions of these spectra allow the maps to be converted to digital images of various atmospheric properties. Fourier transforms of these images indicate significant longitudinally periodic structure. Cross correlations of the Jupiter maps show that the thermal fields are dominated by large slow or stationary features, despite substantial aerosol velocities at those pressure levels. Two mechanisms are proposed as explanations for the above. The first, forcing from the nonrotating deep atmosphere, is explored analytically. For the second, horizontal influence, a numerical model is developed in which resonances within an equatorial channel are initiated by a meridional perturbation velocity at one boundary. Explanations of both theories are given. Dissert. Abstr.

N91-24959 Oxford Univ. (England).
THE OUTER ATMOSPHERE OF 56 PEG: STUDIES OF FLUORESCENT EXCITATION Ph.D. Thesis
Mark Gregory Munday 1990 186 p
Avail: Univ. Microfilms Order No. BRD-91519

The 56 Pegasi (KO IIp), a bright giant which has a white dwarf companion, and a strong UV line spectrum, was studied. It was observed to emit soft X rays like material at 5 x 10(exp 6) K. The observations of 56 Peg available in the literature are reviewed and the evidence for the source of the spectral features like those of hot material is weighted. It is concluded that although an accretion source cannot be ruled out, the relatively narrow UV lines are unlikely to be associated with an accretion disk. The line ratios follow the typical relations observed for other late type stars. Part of the evidence presented is an analysis of high dispersion UV spectra obtained with the IUE, one of which was used for this work. The transition region emission measure distribution is constructed and modeled using the condition of hydrostatic equilibrium. The chromospheric diagnostics are used to derive a model chromosphere with more sophisticated radiative transfer calculations. The spectrum of 56 Peg also show features typical of the radiative excitation processes common in evolved late type stars. A method of calculating these processes, involving a multilevel non-LTE radiative transfer code is presented. Dissert. Abstr.

N91-24385*# Arizona Univ., Tucson. Lunar and Planetary Lab.
SPACEWATCH SEARCH FOR NEAR-EARTH ASTEROIDS
Tom Gehreis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 3 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03A

N91-24390*# Planetary Science Inst., Tucson, AZ.
NEAR-EARTH ASTEROIDS: OBSERVER ALERT NETWORK AND DATABASE ANALYSIS
Donald R. Davis and Clark R. Chapman *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 7 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03A

N91-24391*# Arizona Univ., Tucson. Steward Observatory.
THE STEWARD OBSERVATORY ASTEROID RELATIONAL DATABASE
Mark V. Sykes and Elizabeth M. AlvarezdelCastillo *In its* NASA

Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p Original contains color illustrations (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03A

90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

N91-24960 Pennsylvania Univ., Philadelphia.
ELLIPTICAL POLARIMETRY OF THE ECLIPSING SERPENTID BINARY STARS SX CASSIOPEIAE AND V367 CYGNI Ph.D. Thesis
Nicholas Elias 1990 409 p
Avail: Univ. Microfilms Order No. DA9101152

SX Cassiopeiae and V367 Cygni are massive, semidetached, close binaries which undergo rapid mass transfer. Linear polarimetry was performed on both binary systems in order to study the circumbinary environments. In addition, circular polarimetry was performed. The Flower and Cook Observatory elliptical polarimeter is briefly described. Standard procedures for determining the errors of individual measures are developed. The instrumental elliptical polarization was found to be negligible. The interstellar elliptical polarization was measured for both binary systems and was removed from all measures. Estimates for the size of the SX Cassiopeiae scattering regions and limits of the electron number density are presented. SX Cassiopeiae exhibits long term variability in the structure of its accretion disk and electron scattering regions. Also, there is evidence that the system passed from a quiescent to a chaotic state between 1988 and 1989, most likely as a result of a variable mass transfer rate. In addition, small quantities of neutral H2 were observed in the outer layers of the scattering regions. The bulk of the V367 Cygni circumbinary material is found in an extended disk which consists mainly of neutral H2 and dust.
Dissert. Abstr.

N91-24961 Edinburgh Univ. (Scotland).
THE EDINBURGH/DURHAM SOUTHERN GALAXY CATALOGUE: AN INVESTIGATION INTO THE LARGE-SCALE STRUCTURE OF THE UNIVERSE Ph.D. Thesis
Neil H. Heydon-Dumbleton 1989 238 p
Avail: Univ. Microfilms Order No. BRD-90740

The construction and application of the catalog, which is a data base of information on approximately 1.5 million galaxies covering approximately 2000 sq degrees of the South Galactic Cap, are described. This catalog is based on objective image detection and classification techniques. The raw data for this project are digitized scans of 60 ESO/SERC Atlas plates using the COSMOS high-speed plate measuring machine. The COSMOS machine objectively detects and parameterizes approximately 2 x 10(exp 5) images on each photographic plate. Image deblending software was introduced to ensure the accurate detection and parameterization of images in the crowded regions of compact clusters. Star-galaxy classification and photometric calibration techniques were investigated and optimized to reduce and quantify any systematic variations that could introduce spurious structure. A classification algorithm was used to automatically classify images over the whole range of magnitudes in the survey. Inter-plate calibration is carried out using CCD galaxy sequences for every second field in the catalog. To date, a mosaic of 35 plates covering a continuous region of 1000 sq degrees has been constructed. The variation in the amplitude of the counts across the survey cannot be accounted for by systematic variations in limiting magnitude and so is probable due to large-scale clustering of galaxies. The two-point correlation functions calculated for this 35-plate mosaic confirm a break from power law, though at larger scales than previously estimated. In the context of current theories of galaxy formation, models involving standard cold dark matter with extra large scale power would still seem to be excluded.
Dissert. Abstr.

N91-24962 Iowa State Univ. of Science and Technology, Ames.
SIMULATIONAL STUDIES OF THE FORMATION AND PROPERTIES OF RING GALAXIES AND LEADING ONE-ARM SPIRALS DUE TO GALAXY ENCOUNTERS Ph.D. Thesis
Pnina Lotan-Luban 1990 243 p
Avail: Univ. Microfilms Order No. DA9101364

Simulational studies of colliding disk galaxies are presented, using restricted three-body, hydrodynamical, and kinematic model methods. Depending on the collision parameters, two seemingly different types of disturbed galaxies arise: ring galaxies and leading one-arm spirals. The first research project consists of a quantitative in-depth study of the properties of ring galaxies and their dependence on the collision parameters and the structures of the colliding galaxies. The second research project deals with effects of dynamical friction and nearly head-on multiple passages and merger on a disk galaxy. In the simulations, it is found that for realistic parameters, encounters may give rise to the merger of a ring galaxy with its intruding companion. Furthermore, the multiple passages and merger generate various features in the target disk which are distinct from the structures characteristic of simulated single-passage rings. In view of these differences, a physical classification of collisional ring galaxies based on the presence of an apparent companion, as well as the morphology and kinematics of the target disk is proposed. For a different range of collisional parameters (a single nearly perpendicular, off-center passage of a companion through a disk galaxy), a leading one-arm spiral is formed. Furthermore, the simulations suggest an intimate relationship between ring galaxies, and leading one-arm spirals. The degree of off-centeredness of the perpendicular collision determines which of the two types will form. A method for evaluating the gravitational field created by a flattened mass distribution for use in our restricted three-body code was developed.
Dissert. Abstr.

N91-24963 Ohio State Univ., Columbus.
THE NATURE OF EMISSION-LINE PROFILE VARIABILITY AND THE STRUCTURE OF THE LINE-EMITTING REGIONS IN ACTIVE GALACTIC NUCLEI Ph.D. Thesis
Kirk Thomas Korista 1990 224 p
Avail: Univ. Microfilms Order No. DA9105146

The standard model of active galactic nuclei (AGN) suggests that the broad line regions (BLRs) of high luminosity AGN (HLAGN) should be so large that any variability in the broad emission line (BEL) fluxes should be on timescales of approx. 5 yrs or more. Spectrophotometric observations of 8 radio quiet QSOs over a period of 1 yr revealed definite BEL flux variability in one of these objects and possibly in two others. This may be an indication that the BLRs in HLAGN may be much smaller than that predicted by the standard model. The structure of the BLRs in two Seyfert 1 galaxies was studied through the analysis of their broad emission line profiles and profile variability. Multiple broad line emitting parts were found for Arekelian 120 and Markarian 590 through the construction of difference spectra and profile fitting. The origin of the coronal emission lines was studied, using a photoionization code. It was found that the high ionization iron lines may have their origin in the N sub e approx. 1/cu cm interstellar medium photoionized by the AGN central continuum source. The soft x ray extensions may be due to nuclear x ray emission electron scattered off the coronal line gas.
Dissert. Abstr.

N91-24964 Ohio State Univ., Columbus.
OPTICAL EMISSION VARIABILITY IN THE INTERMEDIATE POLARS FO AQUARII, V1223 SAGITTARII AND AO PISCIUM Ph.D. Thesis
Phillip John Martell 1990 183 p
Avail: Univ. Microfilms Order No. DA9105165

The 1806 time resolved spectra of the intermediate polars FO Aqr, V1223 Sgr and AO Psc were obtained using the Ohio State Intensified Image Dissector Scanner attached to the Perkins 1.8 m telescope of the Ohio State and Ohio Wesleyan Univs. The spectra are flux calibrated and span the range of approx. 4250 to 5050A. FO Aqr exhibits two He II lambda 4686 flux components which vary on the 21 min period of this system and have large

negative radial velocities. The phase shift of the two components is consistent with emission sources which lie at the secondary star and near the expected stream impact site at the outer edge of the He II lambda 4686 emission is due to reprocessing of x rays in hot winds at these two sites. V1223 Sgr also shows evidence of winds, as the H beta line, when phased on the orbital period, shows a strong radial velocity modulation on the redward side of the line, while the blueward side appears to be unmodulated in radial velocity. AO Psc exhibits deep flux modulation in the Balmer lines on the orbit period, a circumstance not unlike that found in FO Aqr. Furthermore, He I lambda 4471 goes into absorption in the line core over a span of approx. 0.25 of the orbit cycle.
Dissert. Abstr.

N91-24386*# Arizona Univ., Tucson. Lunar and Planetary Lab.
COMPOSITIONS OF NEAR-EARTH ASTEROIDS
L. A. Lebofsky and M. L. Nelson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 8 p (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03B

N91-24998*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LARGE CRATERS ON THE METEOROID AND SPACE DEBRIS IMPACT EXPERIMENT Abstract Only
Donald H. Humes *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 30 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-24999*# Centre d'Etudes et de Recherches, Toulouse (France).
STUDY OF METEOROID IMPACT CRATERS ON VARIOUS MATERIALS (AO 138-1). ATTEMPT AT DUST DEBRIS COLLECTION WITH STACKED DETECTORS (AO 138-2) Abstract Only
Jean Claude Mandeville *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 31 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25000*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
METEOROID/SPACE DEBRIS IMPACTS ON MSFC LDEF EXPERIMENTS Abstract Only
Miria Finckenor *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 32 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25001*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
METEOROID/SPACE DEBRIS IMPACTS ON MSFC LDEF EXPERIMENTS Abstract Only
James M. Zwiener *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 33 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25002*# Kent Univ., Canterbury (England). Team Unit for Space Sciences.
FOIL PERFORATION PARTICULATE IMPACT RECORDS ON LDEF MAP AO023: INCIDENT MASS DISTRIBUTIONS Abstract Only
J. A. M. McDonnell and K. Sullivan *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 34 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25005*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PRELIMINARY RESULTS FROM THE CHEMISTRY OF MICROMETEOROID EXPERIMENT (AO 187-1) Abstract Only
Friedrich Horz, R. P. Bernhard, Thomas H. See, J. Warren, Don E. Brownlee, and M. Laurance (Washington Univ., Seattle.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 37 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25006*# Washington Univ., Saint Louis, MO. Center for the Space Sciences.
SIMS ANALYSIS OF EXTENDED IMPACT FEATURES ON LDEF EXPERIMENT Abstract Only
S. Amari, J. Foote, E. K. Jessberger, C. Simon, F. J. Stadermann (Max-Planck-Inst. fuer Kernphysik, Heidelberg, Germany, F.R.), P. Swan, R. Walker, and E. Zinner *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 38 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25007*# North Carolina State Univ., Raleigh.
ION MICROPROBE ELEMENTAL ANALYSES OF IMPACT FEATURES ON INTERPLANETARY DUST EXPERIMENT SENSOR SURFACES Abstract Only
Jerry L. Hunter, Jim J. Wortman, Dieter P. Griffis, and Charles G. Simon (Institute for Space Science and Technology, Inc., Gainesville, FL.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 39 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25008*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LDEF IMPACT CRATERS FORMED BY CARBON-RICH IMPACTORS Abstract Only
T. E. Bunch, F. Radicati diBrozolo, Ronald H. Fleming, David W. Harris, Don E. Brownlee, and Terrence W. Reilly (Hitachi Scientific Instruments, Mountain View, CA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 40 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25009*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IDE SPATIO-TEMPORAL IMPACT FLUXES AND HIGH TIME-RESOLUTION STUDIES OF MULTI-IMPACT EVENTS AND LONG-LIVED DEBRIS CLOUDS Abstract Only
J. Derral Mulholland, S. Fred Singer, John P. Oliver, Jerry L. Weinberg, William J. Cooke, Philip C. Kassel, Jim J. Wortman, Nancy L. Montague, and William H. Kinard (North Carolina State Univ., Raleigh.) *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 41 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25010*# Kent Univ., Canterbury (England). Unit for Space Sciences.
DYNAMIC (COMPUTER) MODELLING OF THE PARTICULATE ENVIRONMENT: TRANSFORMATIONS FROM THE LDEF REFERENCE FRAME TO DECODE GEOCENTRIC AND INTERPLANETARY POPULATIONS
J. A. M. McDonnell and K. Sullivan *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 42 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25011*# POD Associates, Inc., Albuquerque, NM.
LDEF DATA CORRELATION TO EXISTING NASA DEBRIS ENVIRONMENT MODELS Abstract Only
Dale R. Atkinson, Martha K. Allbrooks, and Alan J. Watts *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 43 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25012*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DERIVING THE VELOCITY DISTRIBUTION OF METEOROIDS FROM THE MEASURED METEOROID IMPACT DIRECTIONALITY ON THE VARIOUS LDEF SURFACES Abstract Only
Herbert A. Zook *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 44 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25013*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
M AND D SIG PROGRESS REPORT: LABORATORY SIMULATIONS OF LDEF IMPACT FEATURES Abstract Only
Friedrich Horz, R. P. Bernhard, Thomas H. See, Dale R. Atkinson, and Martha K. Allbrooks (POD Associates, Inc., Albuquerque, NM.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 45 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25014*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PRELIMINARY MICROMETEOROID AND DEBRIS EFFECTS ON LDEF THERMAL CONTROL SURFACES Abstract Only
Martha K. Allbrooks, Dale R. Atkinson, Thomas H. See (Lockheed Engineering and Sciences Co., Houston, TX.), and Friedrich Horz *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 45b (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25015*# Utah State Univ., Logan. Dept. of Physics.
THE INTERSTELLAR GAS EXPERIMENT (IGE) Abstract Only
Don Lind *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 47 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.
For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

N91-24965* National Aeronautics and Space Administration, Washington, DC.
INTERNATIONAL EXPLORATION OF MARS. A SPECIAL BIBLIOGRAPHY
Jun. 1991 66 p
(NASA-SP-7091; NAS 1.21:7091) Avail: NTIS HC A04 CSCL 03B

This bibliography lists 173 reports, articles, and other documents introduced into the NASA Scientific and Technical Information Database on the exploration of Mars. Historical references are cited for background. The bibliography was created for the 1991 session of the International Space University. Author

N91-24383*# Arizona Univ., Tucson. Dept. of Geosciences.
DETERMINATION OF LUNAR ILMENITE ABUNDANCES FROM REMOTELY SENSED DATA
Stephen M. Larson, Jeffrey R. Johnson, and Robert B. Singer *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 6 p Original contains color illustrations (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03B

N91-24384*# Arizona Univ., Tucson.
CONTINUOUS MONITORING OF THE LUNAR OR MARTIAN SUBSURFACE USING ON-BOARD PATTERN RECOGNITION AND NEURAL PROCESSING OF ROVER GEOPHYSICAL DATA
Charles E. Glass, Richard V. Boyd, and Ben K. Sternberg *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources Apr. 1991 21 p Original contains color illustrations (For primary document see N91-24365 16-25)
Avail: NTIS HC/MF A12; 7 functional color pages CSCL 03B

92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.
For related information see *93 Space Radiation.*

N91-24966 Texas Technological Univ., Lubbock.
REAL-TIME SOLAR IMAGING WITH A 19-SEGMENT ACTIVE MIRROR SYSTEM: A STUDY OF THE STANDARD ATMOSPHERIC TURBULENCE MODEL Ph.D. Thesis
Daniel Scott Acton 1990 229 p
Avail: Univ. Microfilms Order No. DA9104798

A 57 actuator segmented active mirror system designed for real time correction of phase distortions due to atmospheric turbulence is described. Solar images and wavefront tilt data obtained with the active mirror system during a recent observing run are discussed. The standard model for imaging through atmospheric turbulence is described. Based on this model, mathematical expressions for the atmospheric coherence diameter, the tilt-corrected wavefront phase structure function, and the corrected and uncorrected modulation transfer functions are developed. Analytical expressions as well as functional relationships obtained through computer modeling are presented. The data are analyzed to check for agreement with the theoretical predictions from the standard model. The analyses indicate that while the standard model may be adequate to describe atmospheric turbulence in some instances, it is often quite inadequate. The analyses also show that the degree of correction performed by the active mirror system was less than ideal. Dissert. Abstr.

N91-24967# California Inst. of Tech., Pasadena. Solar Astronomy Group.
STUDIES OF SOLAR MAGNETIC FIELDS DURING THE RISE OF SOLAR CYCLE 22 Final Report, 1 Oct. 1986 - 30 Sep. 1989
Sara F. Martin 15 Jan. 1991 28 p
(Grant AF-AFOSR-0023-87; AF Proj. 2311)
(AD-A232970; AFOSR-91-0144TR) Avail: NTIS HC/MF A03 CSCL 03/2

New information about the solar cycle and the changing magnetic fields includes: (1) Every solar cycle has a duration of 18 to 22 years even though the peak between successive cycles is approximately 11 years. This means that there are two solar cycles on the sun nearly all of the time; the exception is the few years preceeding solar maximum. (2) A large-scale velocity field was discovered around the perimeter of one of the major active regions that developed during the rise of the current solar cycle. If averaged over a several month interval, the velocity would be of the same order of magnitude as the velocity pattern of the torsional oscillation signal that varies systematically over the solar cycle. The newly discovered velocity pattern can be interpreted as either a severe contamination to the torsional oscillation signal or another way of observing the torsional oscillation velocity field. (3) The analyses of small-scale magnetic fields on the quiet sun has shown that network magnetic fields are continuously being replaced by intranetwork magnetic fields. The replacement occurs when intranetwork magnetic fields collide with network magnetic fields; both polarities are observed to cancel each other at a mean rates of 10(exp 18) Maxwells/hour. The non-cancelling components of the intranetwork magnetic field replace the cancelled components of the network. No net long-term increases

or decreases in magnetic flux occur as a consequence of these processes. GRA

93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

N91-24968 Nottingham Univ. (England).
A STUDY OF THE MUON CONTENT OF EAS INITIATED BY UHE GAMMA RAY EMISSION FROM CYGNUS X-3 Ph.D. Thesis
P. J. Edwards 1990 306 p
Avail: Univ. Microfilms Order No. BRD-91041

The determination of the muon content of extensive air showers (EAS) initiated by ultra high energy (UHE) gamma ray emission from the Galactic X-ray binary Cygnus X-3 is emphasized. The results of observations of Cygnus X-3 made with the Gamma Ray Experiment (GREX) between Apr. 17, 1986 and Sep. 30, 1988 are presented. GREX is a fast timing scintillator array, sensitive to air showers of primary energy greater than approximately 2 x 10(exp 14) eV per particle. The GREX array provides the EAS trigger for the 40 sq m muon detector which is situated at the center of the array. Following a brief survey of cosmic ray physics, the emission characteristics of Cygnus X-3 ranging over 22 decades of energy are described in detail. A review of the theoretical predictions and recent experimental measurements of the muon content of EAS induced by UHE gamma rays is given. The muon detector is described in detail and techniques for determining its response to individual showers are outlined. Background data are then used to establish average air shower characteristics, against which to compare the muon content of showers initiated by UHE gamma rays. After a description of the analysis techniques, the results of the analysis of data recorded during the periods of Apr. 17, 1986 to Jun. 29, 1987 and Jun. 30, 1987 to Sep. 30, 1988 are presented. Dissert. Abstr.

N91-24969*# Iowa State Univ. of Science and Technology, Ames. Dept. of Physics and Astronomy.
THE SEARCH FOR EXTENDED INFRARED EMISSION NEAR INTERACTING AND ACTIVE GALAXIES Final Technical Report, 1 Aug. 1989 - 31 Jan. 1991
Philip N. Appleton 31 Jan. 1991 37 p
(Grant NAG5-1186)
(NASA-CR-187946; NAS 1.26:187946) Avail: NTIS HC/MF A03 CSCL 03B

The following subject areas are covered: the search for extended far IR emission; the search for extended emission in galaxy groups; a brief review of the flattening algorithm; the target groups; extended emission from groups and intergalactic HI clouds; and morphological image processing. Author

N91-24970*# Alabama Univ., Huntsville.
A MEASUREMENT OF THE ENERGY SPECTRA OF COSMIC RAYS FROM 20 TO 1000 GeV PER AMU Semiannual Report
John C. Gregory, Y. Takahashi, T. Hayashi, C. Thoburn, T. A. Parnell, John W. Watts, Jr., P. H. Fowler, M. R. W. Masheder, and James H. Derrickson (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) Mar. 1991 30 p
(Grant NAGw-2023)
(NASA-CR-188211; NAS 1.26:188211; UAH-5-32401) Avail: NTIS HC/MF A03 CSCL 03B

A group collaboration was made in the development of the Bristol University Gas Spectrometer number 4 (BUGS 4). The BUGS 4 detector is designed to measure the charge spectrum for species between oxygen and the iron peak as a function of energy per nucleon, between 20 and 1000 GeV/amu. It is particularly concerned with energies above 50 GeV/amu. The high energy component is considerably less affected by propagation through the interstellar medium than the lower energy component and is expected to approach the original charge spectrum of the source more closely. This information allows one to unravel the effects of cosmic ray production, acceleration, and propagation. The detector is described in total detail. The method of estimating the charge and energy of a cosmic ray depends on the energy of the particle. Calculations and experiments lead to the expectation of a nearly constant charge resolution of about 0.2 charge units over the whole energy range except 4.5 less than gamma less than 20. In this band, the experiment is insensitive to energy. A balloon flight is planned in 1993. Author

N91-24994*# Dublin Inst. for Advanced Studies (Ireland).
THE LDEF ULTRA HEAVY COSMIC RAY EXPERIMENT Abstract Only
D. OSullivan, A. Thompson, J. Bosch, R. Keegan, K.-P. Wenzel, A. Smit, and C. Domingo (Universidad Autonoma de Barcelona, Bellaterra, Spain) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 25 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25003*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
METEOROID AND ORBITAL DEBRIS RECORD OF THE LONG DURATION EXPOSURE FACILITY Abstract Only
Mike Zolensky, Thomas H. See, Charles G. Simon, Martha K. Allbrooks, and Dale R. Atkinson (POD Associates, Inc., Albuquerque, NM.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 35 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

N91-25004*# Kent Univ., Canterbury (England). Unit for Space Science.
PARTICULATE IMPACTS ON THE UHCRE COSMIC RAY EXPERIMENT TEFLON COVERS: THE ESA PROGRAMME Abstract Only
J. A. M. McDonnell, M. T. Paley, T. J. Stevenson, A. Thompson, D. OSullivan, K.-P. Wenzel, and G. H. Schwehm (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 36 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

99 GENERAL

N91-24971# National Technical Information Service, Springfield, VA.
DIRECTORY OF FEDERAL LABORATORY AND TECHNOLOGY RESOURCES: A GUIDE TO SERVICES, FACILITIES, AND EXPERTISE
Edward J. Lehmann, ed., Susan Trabert, and Tracy Hunt Jan. 1990 379 p
(ISBN-0-934213-21-6) Avail: NTIS HC/MF A17

The Directory of Federal Laboratory and Technology Resources cross-references more than 1100 Federal laboratories and engineering centers in five ways, including by subject, by state, and by laboratory. A special listing includes the Technology Transfer office and contact person for every Federal laboratory. Twenty four categories of science areas are included. Author

N91-24972*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FIRST LDEF POST-RETRIEVAL SYMPOSIUM ABSTRACTS
Arlene S. Levine, comp. Jun. 1991 145 p Symposium held in Kissimmee, FL, 2-8 Jun. 1991
(NASA-CP-10072; NAS 1.55:10072) Avail: NTIS HC/MF A07 CSCL 22A

The LDE facility was designed to better understand the environments of space and the effects of prolonged exposure in these environments on future spacecraft. The symposium abstracts presented here are organized according to the symposium agenda into five sessions. The first session provides an overview of the LDEF, the experiments, the mission, and the natural and induced environments the spacecraft and experiments encountered during the mission. The second session presents results to date from studies to better define the environments of near-Earth space. The third session addresses studies of the effects of the space environments on spacecraft materials. The fourth session addresses studies of the effects of the space environments on spacecraft systems. And the fifth session addresses other subjects such as results of the LDEF life science and crystal growth experiments. For individual titles, see N91-24973 through N91-25098.

N91-24973*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

LDEF ATTITUDE MEASUREMENT USING A PINHOLE CAMERA WITH A SILVER/OXYGEN ATOM DETECTOR Abstract Only **c35**

John C. Gregory (Alabama Univ., Huntsville.) and P. N. Peters *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 3 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 14B

A small device designed to measure the orbital attitude stability of the Long Duration Exposure Facility (LDEF) spacecraft is examined. The device used the reaction of Ag with O atoms, which convert the metal to a nonconducting black appearing oxide with high efficiency. The atmosphere at LDEF altitudes consists of more than 90 pct. atomic O. The device is a small hemispheric Ag surface facing a pinhole in a metal plate on the front surface of the satellite. It was expected that the stream of O atoms, travelling at a relatively velocity of 8 km/s would pass through the pinhole and strike the Ag surface at the geometric center, producing a circular black spot. In fact, the position of the spot has clearly shown that the LDEF was rotated by 8.0 + or - 0.4 deg from its nominal attitude, but that it was remarkably stable about this offset. The ellipticity of the recorded spot was attributed to a yaw oscillation of + or - 0.2 deg, however it was previously noted, that the co-rotation of the Earth's atmosphere should produce a sweeping of the atom beam vector of ca. + or - 1.5 deg about the surface normal. Such an effect was not visible in this experiment. Author

N91-24974*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

LDEF SPACE ENVIRONMENTS OVERVIEW Abstract Only **c18**

William H. Kinard *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 4 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 22B

The Long Duration Exposure Facility (LDEF) was launched into an Earth orbit during a period of minimum solar activity. It was retrieved almost 6 years later during a period of near maximum solar activity. In flight, the LDEF was passively stabilized in three axes and it flew in a near circular orbit having an inclination of 28.5 degs and an initial altitude of approx. 257 nautical miles. When the LDEF was retrieved, the orbit had decayed to an altitude of approx. 180 nautical miles. Specifically, the LDEF flew with one surface always facing the trailing direction, one surface facing Earth, and one surface facing into space. These facts made the LDEF an ideal platform to expose experiments to study the space environments and the effects of these environments on spacecraft materials and systems. An overview is provided of the specific space environments to which the LDEF experiments were exposed. The specific features are also pointed out of the LDEF that allow the effects of different environments to be isolated. Author

N91-24975*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

USE OF THE LONG DURATION EXPOSURE FACILITY'S THERMAL MEASUREMENT SYSTEM FOR THE VERIFICATION OF THERMAL MODELS Abstract Only **c35**

William M. Berrios *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 5 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 14B

Results are presented of the comparison between the Long Duration Exposure Facility (LDEF) Thermal Measurements Systems (THERM) recorded temperature data and the predicted values as calculated prior to the LDEF deployment. The postflight thermal model was verified and calculated temperature uncertainties were reduced to under + or - 18 F from the preflight uncertainties of + or - 40 F. The THERM consisted of 8 temperature sensors, a shared tape recorder, a standard LDEF flight battery, and an electronics control box. The temperatures were measured at selected locations on the LDEF structure interior during the first 490 days of flight and recorded for postflight analysis. After the recorder was recovered from space, the tape recorder was recovered and the data reduced for comparison to the LDEF predicted temperatures. By comparing the calculated values to the measured data, a verified thermal model that presents the best agreement with the THERM data was obtained. The THERM experiment provided an economical way of performing a postflight verification of the LDEF Thermal Model by recording a limited number of flight temperatures on typical locations of the LDEF structure. Author

N91-24976*# Science Applications International Corp., Glendora, CA.

MEASURED SPACE ENVIRONMENTAL EFFECTS TO LDEF DURING RETRIEVAL Abstract Only **c18**

Carl R. Maag and W. Kelly Linder (Space Systems Div. AFSC Field Office, Houston, TX.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 6 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 22B

The Interim Operational Contamination Monitor (IOCM) is an attached shuttle payload to the Long Duration Exposure Facility (LDEF) that was used on 2 earlier flights to quantify the contamination deposited during the course of the missions. The IOCM can characterize by direct measurement the deposition of molecular and particulate contamination during any phase of flight. Also, the IOCM actively measures the optical property changes of thermal control surfaces by calorimetry, the flux of the ambient atomic oxygen environment, the incident solar flux, and the absolute ambient pressure in the payload bay. The IOCM also provides a structure and sample holders for the exposure of passive material samples to the space environment, e.g., thermal cycling, atomic oxygen, and micrometeoroids and/or debris. Some of the more salient results from the flight suggests that the payload bay was slightly contaminated during both the prelaunch phase of the mission and after the deployment of the SYNCOM IV payload. Measurements during the postflight phases, i.e., ferry flight and deintegration processing, show negligible to very low mass deposition. The results of the data are discussed in depth.

Author

N91-24977*# Boeing Aerospace and Electronics Co., Seattle, WA.

MIGRATION AND GENERATION OF CONTAMINANTS FROM LAUNCH THROUGH RECOVERY: LDEF CASE HISTORY Abstract Only **c18**

E. Russ Crutcher, L. S. Nishimura, K. J. Warner, and W. W. Wascher *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 7 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 22B

The migration of contaminants to and between Long Duration Exposure Facility (LDEF) surfaces reveals new information relevant to all future space missions. The surface of the LDEF satellite

closely paralleled over seven meters of the shuttle during one launch and one reentry. Transfer of contaminants from the shuttle bay to the payload were documented and partially quantified for both the launch and recovery separately. LDEF carried a load of volatile silicones and hydrocarbons into orbit which were then polymerized by UV radiation into tough, dark brown stains on exposed surfaces. The distribution of these stains is providing new information on deposition mechanisms that should be studied on future missions. Electrostatic effects, diffusional flow, and effects due to small surface temperature differences at the time of UV exposure are suggested. The types of functional groups present in the LDEF deposit it nearly identical to stains recovered from other spacecraft. These stains were remarkably stable in low Earth orbit even with atomic oxygen exposure if the amount of silicones present was sufficient to create a sealing layer of silicon dioxide over the dark brown stain beneath. Author

N91-24978*# Boeing Co., Washington, DC. Defense and Space Group.

LDEF CONTAMINANTS ANALYSIS DATA Abstract Only c18

E. Russ Crutcher, K. J. Warner, W. W. Washer, and L. S. Nishimura *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 8 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 22B

Modification of surface texture for Ram Facing FEP Teflon on the Long Duration Exposure Facility (LDEF) satellite is documented. Photos of changes in surface texture if thermal blanket material with position on tray C-08 are presented. Infrared spectra and photographic documentation of molecular film deposits on LDEF surfaces by location is reported. Results of a survey of the functional groups and elemental composition of the brown film found widely distributed on the surface of LDEF is shown. A partial photographic catalog of LDEF particulate contaminants is included. A set of photos of particles collected or photographed in place on the surface of LDEF is shown. Particle counts and surface obscuration data for the LDEF satellite are reported. The surface data in tables and charts is presented for the LDEF satellite by location. Author

N91-24979*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ORGANIC CONTAMINATION OF LDEF Abstract Only c18

Gale A. Harvey *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 9 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 22B

A brown stain of varying thickness was present on most of the exterior surface of the retrieved Long Duration Exposure Facility (LDEF). Tape lifts of Earth-end LDEF surfaces taken showed that the surface particle cleanliness immediately after retrieval was very good, but faint footprints of the tape strips on the tested surfaces indicated a very faint film was removed by the tape. Solvent wipes of these surfaces showed that the stain was not amenable to standard organic solvent removal. Infrared spectra of optical windows from tray E5 show that the organic film is hydrocarbon in composition, but is not similar to the oil that seeped from tray C12. Very dark and heavy deposits of the stain is present at openings and vents to the interior of LDEF. Heavy brown and blue-green deposits are present in the interior of LDEF where sunlight penetrated through cracks and vent openings. The exterior of LDEF had significant areas painted with a white polyurethane paint for thermal control, and almost all of the interior was painted with a black polyurethane paint. Brown staining is consistent with outgassing of hydrocarbons from these paints by rapid solar UV induced polymerization of the outgassed hydrocarbons when they hit sunlight exposed areas. Author

N91-24980*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

THE IONIZING RADIATION ENVIRONMENT OF LDEF PRERECOVERY PREDICTIONS Abstract Only c72

John W. Watts, Jr., James H. Derrickson, T. A. Parnell, G. J. Fishman, A. Harmon, E. V. Benton, A. L. Frank, and Wolfgang Heinrich (Siegen Univ.,, Germany, F.R.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 11 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 20H

The Long Duration Exposure Facility (LDEF) was exposed to several sources of ionizing radiation while in orbit. The principal ones were trapped belt protons and electrons, galactic cosmic rays, and albedo particles (protons and neutrons) from the atmosphere. Large solar flares in 1989 may have caused a small contribution. Prior to the recovery of the spacecraft, a number of calculations and estimates were made to predict the radiation exposure of the spacecraft and experiments. These were made to assess whether measurable radiation effects might exist, and to plan the analysis of the large number of radiation measurements available on the LDEF. Calculations and estimates of total dose, particle fluences, linear energy transfer spectra, and induced radioactivity were made. The principal sources of radiation is described, and the preflight predictions are summarized. Author

N91-24981*# Naval Research Lab., Washington, DC.

GAMMA RADIATION SURVEY OF THE LDEF SPACECRAFT Abstract Only c72

G. W. Phillips, S. E. King, R. A. August, J. C. Ritter, J. H. Cutchin, P. S. Haskins, J. E. McKisson, D. W. Ely, A. G. Weisenberger, and R. B. Piercey (Mississippi State Univ., Mississippi State.) et al *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 12 (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 20H

The retrieval of the Long Duration Exposure Facility (LDEF) spacecraft after nearly 6 years in orbit offered a unique opportunity to study the long term buildup of induced radioactivity in the variety of materials on board. The first complete gamma ray survey was conducted of a large spacecraft on LDEF shortly after its return to Earth. A surprising observation was the large Be-7 activity which was seen primarily on the leading edge of the satellite, implying that it was picked up by LDEF in orbit. This is the first known evidence for accretion of a radioactive isotope onto an orbiting spacecraft. Other isotopes seen during the survey, the strongest being Na-22 and Mn-54, are all attributed to activation of spacecraft components in orbit. Be-7 is a spallation product of cosmic rays on nitrogen and oxygen in the upper atmosphere. However, the observed density is much greater than expected due to cosmic ray production in situ. This implies transport of Be-7 from much lower altitudes up to the LDEF orbit. Author

N91-24982*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

THE INTERACTIONS OF ATMOSPHERIC COSMOGENIC RADIONUCLIDES WITH SPACECRAFT SURFACES Abstract Only c72

John C. Gregory, G. J. Fishman, A. Harmon, T. A. Parnell, G. Herzog, J. Klein, and A. J. T. Jull (Arizona Univ., Tucson.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 13 Submitted for publication (For primary document see N91-24972 16-99)

Avail: NTIS HC/MF A07 CSCL 20H

The discovery of the cosmogenic radionuclide Be-7 on the front surface of the Long Duration Exposure Facility (LDEF) has opened new opportunities to study several unexplored regions of space science. The experiments have shown that the Be-7 found was concentrated in a thin surface layer of spacecraft material. The only reasonable source of the isotope is the atmosphere through which the spacecraft passed. It is expected that the uptake of Be in such circumstances will depend on the chemical form of the Be and the chemical nature of the substrate. It was found that the observed concentration of Be-7 does differ between metal surfaces and organic surfaces such as PTFE (Teflon). It is noted however, that (1) organic surfaces are etched by the atomic oxygen found under these orbital conditions, and (2) the relative velocity of the species is 8 km/s relative to the surface and the interaction

chemistry and physics may differ from the norm. Be-7 is formed by disintegration of O and N nuclei under cosmic ray proton bombardment. Many other isotopes are produced by cosmic ray reactions, and some of these are suited to measurement by the extremely sensitive methods of accelerator mass spectrometry.
Author

N91-24983*# Royal Aircraft Establishment, Farnborough (England). Space Dept.
SURFACE ACTIVATION OF CONCORDE BY Be-7 Abstract Only **c72**
P. R. Truscott, C. S. Dyer, and J. C. Flatman *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 14 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

Activation analysis of two airframe parts from Concorde aircraft has identified the presence of Be-7, a nuclide which was found by other investigators to have been collected on the forward edge of the Long Duration Exposure Facility (LDEF) structure. The results of the Concorde analysis indicate that this phenomenon is very much a surface effect, and that the areal densities of the Be-7 are comparable to those found for LDEF. The collection of Be-7 by the aircraft must be greater than in the case of LDEF (since the duration for which Concorde is accumulating the nuclide is shorter) and is of the order of 1.9 to 40 nuclei sq cm/s, depending upon assumptions made regarding the efficiency of the process which removes the radionuclide.
Author

N91-24984*# California Univ., Berkeley. Lawrence Berkeley Lab.
RADIOACTIVITIES OF LONG DURATION EXPOSURE FACILITY (LDEF) MATERIALS: BAGGAGE AND BONANZAS Abstract Only **c72**
Alan R. Smith and Donna L. Hurley *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 15 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

Radioactivities in materials onboard the returned Long Duration Exposure Facility (LDEF) satellite were studied by a variety of techniques. Among the most powerful is low background Ge semiconductor detector gamma ray spectrometry. The observed radioactivities are of two origins: those radionuclides produced by nuclear reactions with the radiation field in orbit and radionuclides present initially as contaminants in materials used for construction of the spacecraft and experimental assemblies. In the first category are experiment related monitor foils and tomato seeds, and such spacecraft materials as Al, stainless steel, and Ti. In the second category are Al, Be, Ti, Va, and some special glasses. Consider that measured peak-area count rates from both categories range from a high value of about 1 count per minute down to less than 0.001 count per minute. Successful measurement of count rates toward the low end of this range can be achieved only through low background techniques, such as used to obtain the results presented here.
Author

N91-24985*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
INDUCED RADIOACTIVITY IN LDEF COMPONENTS Abstract Only **c72**
B. A. Harmon, G. J. Fishman, T. A. Parnell, and C. E. Laird (University of Eastern Kentucky, Richmond.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 16 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

The systematics of induced radioactivity on the Long Duration Exposure Facility (LDEF) were studied in a wide range of materials using low level background facilities for detection of gamma rays. Approx. 400 samples of materials processed from structural parts of the spacecraft, as well as materials from onboard experiments, were analyzed at national facilities. These measurements show the variety of radioisotopes that are produced with half-lives greater than 2 wks, most of which are characteristic of proton induced reactions above 20 MeV. For the higher activity, long lived isotopes, it was possible to map the depth and directional dependences of the activity. Due to the stabilized configuration of the LDEF, the induced radioactivity data clearly show contributions from the anisotropic trapped proton flux in the South Atlantic Anomaly. This effect is discussed, along with evidence for activation by galactic protons and thermal neutrons. The discovery of Be-7 was made on leading side parts of the spacecraft, although this was though not to be related to the in situ production of radioisotopes from external particle fluxes.
Author

N91-24986*# Los Alamos National Lab., NM.
MEASUREMENTS OF INDUCED RADIOACTIVITY IN SOME LDEF SAMPLES Abstract Only **c72**
C. E. Moss and R. C. Reedy *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 17 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

Twenty-six stainless steel trunnion samples, five aluminum end support retainer plate samples, two aluminum keel plate samples, and two titanium clips were analyzed. The shielded high purity germanium detectors used had efficiencies of 33, 54, and 80 pcts. at 1332 keV. Detector efficiencies as a function of energy and corrections for self absorption in the samples were determined with calibrated sources, unactivated control samples, and calculations. Several measurements were made on most samples. In the trunnion samples, Mn-54 and Co-57 were seen and limits were obtained for other isotopes. The results agree well with 1-D activation calculations for an anisotropic trapped proton model. In the aluminum samples, Na-22 and Be-7 were seen. Other results are presented.
Author

N91-24987*# Massachusetts Inst. of Tech., Cambridge. Nuclear Reactor Lab.
CHARGED PARTICLE ACTIVATION STUDIES ON THE SURFACE OF LDEF SPACECRAFT Abstract Only **c72**
Ilhan Olmez, Forrest Burns, and Paul L. Sagalyn (Army Materials Technology Lab., Watertown, MA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 18 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

High energy proton induced nuclear reaction products are examined using seven elements, namely: Al, Si, Ni, Co, Zr, Ta, and W. Activities were detected due to Na-22 from Al, Co-56 from Ni, Co-58 from Cu, and Y-88 from Zr targets. No induced activity was observed in Si, Ta, and W, most probably due to the long cooling times. Only Zr sample contained a weak Be-7 peak, although Ta and W were also located at the leading edge of the spacecraft. Gamma rays of individual isotopes were measured using high resolution Ge(Li) solid state detector coupled to 4096 multichannel analyzer. Activities were calculated for Co-56 (846 keV) and Co-57 (122 and 136 keV's) at the time of the entry of the spacecraft and found to be 0.014 + or - c/sec g, 0.018 + or - 0.002 c/sec g, and 0.0024 + or - 0.0007 c/sec g, respectively.
Author

N91-24988*# Westinghouse Savannah River Co., Aiken, SC.
GAMMA RAY SPECTROMETRY OF LDEF SAMPLES AT SRS Abstract Only **c72**
Willard G. Winn *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 19 (For primary document see N91-24972 16-99)
(Contract DE-AC09-89SR-18035)
Avail: NTIS HC/MF A07 CSCL 20H

A total of 31 samples from Long Duration Exposure Facility (LDEF), including materials of Al, V, and steel trunnions were analyzed by ultralow level gamma spectrometry. The study quantified particle induced activations of Na-22, Sc-46, Cr-51, Mn-54, Co-56, Co-57, Co-58, and Co-60. The samples of trunnion sections exhibited increasing activity toward the outer end of the trunnion and decreasing activity toward its radial center. The trunnion sections did not include an end piece that collects

noticeable Be-7 on its leading surface. No significant Be-7 was detected in the samples analyzed. The most sensitive analyses were performed with a 90 pct. efficient HPGe gamma ray detector, which is enclosed in a purged active/passive active shield.
Author

N91-24989*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
CHARGED PARTICLE LET-SPECTRA MEASUREMENTS ABOARD LDEF Abstract Only **c72**
I. Csige, E. V. Benton, A. L. Frank, L. A. Frigo, E. R. Benton (San Francisco Univ., CA.), T. A. Parnell, and John W. Watts, Jr. *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 20 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

The linear energy transfer (LET) spectra of charged particles was measured in the 5 to 250 keV/micron (water) interval with CR-39 and in the 250 to 1000 keV/micron (water) interval with polycarbonate plastic nuclear track detectors (PNTDs) under different shielding depths in the P0006 experiment. The optimal processing conditions were determined for both PNTDs in relation to the relatively high track densities due to the long term exposure in space. The total track density was measured over the selected samples, and tracks in coincidence on the facing surfaces of two detector sheets were selected for measuring at the same position on each sheet. The Short Range (SR) and Galactic Cosmic Ray (GCR) components were measured separately. The integral dose and dose rate spectra of charged particles are also given. The high LET portion of the LET spectra was measured with high statistical accuracy. This is a unique result of this experiment due to the low flux of this type of particle under typical shielding conditions. Author

N91-24990*# Grumman Aerospace Corp., Bethpage, NY.
THERMOLUMINESCENT DOSIMETER MEASUREMENTS AND ANALYSIS FOR LDEF EXPERIMENT M0006 Abstract Only **c72**
Michael C. Stauber, J. Chang, and T. Kantorcik *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 21 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

Glow curve measurements are reported up to 600 C of (Thermoluminescent Dosimeter Measurement) TLD-100 (LiF) samples deployed on Long Duration Exposure Facility (LDEF) and retained as ground control. Lab exposure simulations are also reported with Co-60 radiation, low energy light ions and high energy protons in an effort to replicate the glow curves, especially the high temperature peaks observed in the LDEF TLD specimens. The evidence to date clearly shows the effect of inflight anneal on the low temperature part of the glow curve. It also shows that the high temperature part of the glow curve appears due to ion dose deposition. Initial correlations between high temperature glow peaks and effective LET of the registered dose is given. Author

N91-24991*# Science Applications International Corp., Prospect, TN.
RADIATION CALCULATIONS AND COMPARISONS WITH DATA Abstract Only **c72**
T. W. Armstrong and B. L. Colborn *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 22 Sponsored by Marshall Space Flight Center (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

In conjunction with the analysis of data from the Long Duration Exposure Facility (LDEF) ionizing radiation dosimetry, a calculation program was established to aid in data interpretation and to assess the accuracy of current radiation environments and effects models for future mission applications. Initial estimates of LDEF exposure to trapped, galactic, and atmospheric (albedo) radiation sources were made, and the radiation environment (primary and secondary particle spectra) and several radiation effects (induced radioactivity and dose) for varying amounts of LDEF shielding were calculated for a simplified LDEF mass model. Preliminary comparisons of the calculated results were made with the induced radioactivity measurements for several LDEF parts and with preliminary dose data from several experiments (P0004, P0006, and M0004). Predictions were compared with the radioactivity induced in the aluminum clamps holding the experiment trays and in the stainless steel trunnions to test a recently developed theory of trapped proton anisotropy. Author

N91-24992*# Science Applications International Corp., Prospect, TN.
LDEF GEOMETRY/MASS MODEL FOR RADIATION ANALYSES Abstract Only **c72**
B. L. Colborn and T. W. Armstrong *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 23 Sponsored by Marshall Space Flight Center (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

A 3-D geometry/mass model of Long Duration Exposure Facility (LDEF) was generated to aid in the interpretation of ionizing radiation experiments relative to the influence of varying shielding distributions around the dosimetry, and to allow more definitive calculations and comparisons with the measured data. This model takes into account the major individual structural members of the LDEF spacecraft, the mass in each experiment tray, and, for selected trays containing ionizing radiation dosimetry, major parts within the tray are modeled. The geometry/mass model, together with a ray tracing algorithms, was programmed for use both as a stand alone code in determining 3-D shielding distributions at dosimetry locations, and as a geometry module that can be interfaced with radiation transport codes. Author

N91-24993*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
RADIATION EXPOSURE OF LDEF: INITIAL RESULTS Abstract Only **c72**
E. V. Benton, A. L. Frank, E. R. Benton, I. Csige (San Francisco Univ., CA.), T. A. Parnell, and John W. Watts, Jr. *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 24 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

Initial results from Long Duration Exposure Facility (LDEF) include radiation detector measurements from four experiments; P0006, P0004, M0004, and A0015. The detectors were located on both the leading and trailing edges of the orbiter and also at the Earthside end. This allowed the directional dependence of the incoming radiation to be measured. Total absorbed doses from thermoluminescent detectors (TLDs) verified the predicted spatial east-west dose dependence of a factor of approx. 2.5, due to trapped proton anisotropy in the South Atlantic Anomaly (SAA). On the trailing edge of the orbiter, a range of doses from 664 to 291 rad were measured under nominal shielding of 0.42 to 8.45 g/sq cm. A second set of detectors near this locations results are also given. On the leading edge, doses of 258 to 210 rad were found under shielding of 1.25 to 2.48 g/sq cm. Initial charged particle LET (linear energy transfer) spectra, fluxes, doses, and dose equivalents, for LET in H2O greater than or = 5 keV/micron, were measured with plastic nuclear track detectors located in the four experiments. Also, preliminary data on low energy neutrons were obtained from detectors containing (6)LiF foils. Author

N91-24994*# Dublin Inst. for Advanced Studies (Ireland).
THE LDEF ULTRA HEAVY COSMIC RAY EXPERIMENT Abstract Only **c93**
D. OSullivan, A. Thompson, J. Bosch, R. Keegan, K.-P. Wenzel, A. Smit, and C. Domingo (Universidad Autonoma de Barcelona, Bellaterra, Spain) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 25 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

The Long Duration Exposure Facility (LDEF) Ultra Heavy Cosmic

Ray Experiment (UHCRE) used 16 side viewing LDEF trays giving a total geometry factor for high energy cosmic rays of 30 sq m sr. The total exposure factor was 170 sq m sr y. The experiment is based on a modular array of 192 solid state nuclear track detector stacks, mounted in sets of 4 pressure vessels (3 experiment tray). The extended duration of the LDEF mission has resulted in a greatly enhanced potential scientific yield from the UHCRE. Initial scanning results indicate that at least 2000 cosmic ray nuclei with Z greater than 65 were collected, including the world's first statistically significant sample of actinides. Postflight work to date and the current status of the experiment are reviewed. Provisional results from analysis of preflight and postflight calibrations are presented. Author

N91-24995*# Hulburt (E. O.) Center for Space Research, Washington, DC.
PRELIMINARY RESULTS FROM THE HEAVY IONS IN SPACE EXPERIMENT Abstract Only **c72**
J. H. Adams, Jr., L. P. Beahm, and A. J. Tylka (Universities Space Research Association, Washington, DC.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 26 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

The Heavy Ions In Space (HIIS) experiment is intended to provide a deep survey of intensely ionizing particles in low earth orbit. Intensely ionizing particles produce single event effects in microelectronic components and are now recognized as the principal cause of spacecraft anomalies. These particles also make an important contribution to radiation doses. Besides the practical applications, HIIS data will be used to study several important scientific questions. By measuring heavy ions that stop in HIIS, the anomalous component of cosmic rays can be studied, evidence can be searched for of heavy ions trapped in the earth's magnetic field and by comparing HISS data with observations from outside the magnetosphere, the mean ionic charge state can be determined of solar energetic particles. HIIS will also record relativistic ultraheavy galactic cosmic rays. Their elemental composition will be measured from tin to uranium. Results are presented on the elemental resolution for stopping heavy ions and relativistic heavy ions. Author

N91-24996*# Kiel Univ. (Germany, F.R.). Inst. fuer Reine und Angewandtd Kernphysik.
HEAVY ION MEASUREMENT ON LDEF Abstract Only **c72**
R. Beaujean, D. Jonathal, and W. Enge *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 27 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

The Kiel Long Duration Exposure Facility (LDEF) experiment M0002, mounted on experiment tray E6, was designed to measure the heavy ion environment by means of CR-39 plastic solid state track detectors. The detector stack with a size of 40x34x4.5 cu cm was exposed in vacuum covered by thermal protection foils with a total thickness of approx. 14 mg/sq cm. After etching small samples of the detector foils tracks with Z greater than or = 6 could be easily detected on a background of small etch pits, which were probably produced by secondaries from proton interactions. The LDEF orientation with respect to the magnetic field lines within the South Atlantic Anomaly (SAA) is expected to be constant during the mission. Therefore, the azimuth angle distribution was measured on the detector foils for low energy stopping particles. All detected arrival directions are close to a plane perpendicular to the magnetic field line of -20 deg declination and -40 deg inclination at location 34 deg W and 27 deg S. Together with the steep energy spectrum, this spatial distribution close to the mirror plane in the SAA is an evidence that heavy ions were detected from a radiation belt population. Author

N91-24997*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
SUMMARY OF IONIZING RADIATION ANALYSIS ON THE LONG DURATION EXPOSURE FACILITY Abstract Only **c72**
T. A. Parnell *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 28 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

The Ionizing Radiation Special Investigation Group (IRSIG) for the Long Duration Exposure Facility (LDEF) was established to perform radiation measurements and analysis not planned in the original experiments, and to assure availability of LDEF analysis results in a form useful to future missions. The IRSIG has organized extensive induced radioactivity measurements throughout LDEF, and a comprehensive program to compare the LDEF radiation measurements to values calculated using environment models. The activities and present status of the Group is described. The ionizing radiation results presented is summarized. Author

N91-24998*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LARGE CRATERS ON THE METEOROID AND SPACE DEBRIS IMPACT EXPERIMENT Abstract Only **c90**
Donald H. Humes *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 30 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

The distribution around the Long Duration Exposure Facility (LDEF) of 532 large craters in the Al plates from the Meteoroid and Space Debris Impact Experiment (S0001) is discussed along with 74 additional large craters in Al plates donated to the Meteoroid and Debris Special Investigation Group by other LDEF experimenters. The craters are 0.5 mm in diameter and larger. Crater shape is discussed. The number of craters and their distribution around the spacecraft are compared with values predicted with models of the meteoroid environment and the manmade orbital debris environment. Author

N91-24999*# Centre d'Etudes et de Recherches, Toulouse (France).
STUDY OF METEOROID IMPACT CRATERS ON VARIOUS MATERIALS (AO 138-1). ATTEMPT AT DUST DEBRIS COLLECTION WITH STACKED DETECTORS (AO 138-2) Abstract Only **c90**
Jean Claude Mandeville *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 31 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

Part of the Long Duration Exposure Facility (LDEF) tray allocated to French experiments, known as FRECOPA payload, was devoted to the study of dust particles. Two passive experiments were flown: one composed of a set of glass and metallic samples and one composed of multilayer thin foils detectors. In addition to these experiments, a broad variety of materials were exposed to the bombardment of microparticles and provide more data. Thick target experiment comprises selected metallic (Al, Au, Cu, W, Stainless Steel) 250 microns thick and glass surfaces 1.5 mm thick. Crater size distribution from these thick target experiments enable, with the aid of lab calibrations by solid particle accelerators, the evaluation of the incident microparticle flux in the near earth environment. The aim of the multiple foil penetration and collection experiment is primarily to study the feasibility of multilayer thin film detectors acting as energy sorters in order to collect micrometeoroids, if not in their original shape, at least as 'breakup' fragments suitable for chemical analysis. Foil thicknesses range from 0.75 to 5 microns of Al. Author

N91-25000*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
METEOROID/SPACE DEBRIS IMPACTS ON MSFC LDEF EXPERIMENTS Abstract Only **c90**
Miria Finckenor *In* NASA, Langley Research Center, First LDEF

Post-Retrieval Symposium Abstracts Jun. 1991 p 32 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

The numerous meteoroid and space debris impacts found on AO171, AO034, S0069, and other MSFC experiments are examined. Besides those impacts found by the Meteoroid and Debris Special Investigative Group at KSC, numerous impacts of less than 0.5 mm were found and photographed. The flux and size distribution of impacts are presented as well as EDS analysis of impact residue. Emphasis is on morphology of impacts in the various materials, including graphite/epoxy composites, polymeric materials, optical coatings, thin films, and solar cells. Author

N91-25001*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
METEOROID/SPACE DEBRIS IMPACTS ON MSFC LDEF EXPERIMENTS Abstract Only **c90**
James M. Zwiener *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 33 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

A number of unusual effects are presented that were observed on the TCSE test samples, front cover, and structural components. These include induced UV fluorescence in some materials, the migration and degradation of KRS-5 materials, atomic oxygen (AO), and contaminant texturing and discoloration, and meteoroid and debris impacts. These effects and their causes are discussed. Author

N91-25002*# Kent Univ., Canterbury (England). Team Unit for Space Sciences.
FOIL PERFORATION PARTICULATE IMPACT RECORDS ON LDEF MAP AO023: INCIDENT MASS DISTRIBUTIONS Abstract Only **c90**
J. A. M. McDonnell and K. Sullivan *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 34 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

An array of multiple foils varying from 1.5 to 3.0 microns exposed on Long Duration Exposure Facility's (LEDF's) geocentrically stabilized exposure platform provides perforation distributions which relate to particulate flux mass distributions and impact velocity in LDEF's orbital reference frame. The application of physical modeling enables a preliminary separation into orbital and interplanetary components, both of which have differing velocities and hence penetration effectiveness. Thin foil hypervelocity calibration data and parametric penetration formulae developed to relate target hole diameter to projectile dimensions are critically examined and a new formula offered for the ballistic limit situation. Incorporating projectile density, target density, and target strength and dimensional scaling from submicron particulates to centimeter scale data, it contrast very significantly with previous formulae in the interpretation of space impact data. Perforation flux distributions for the leading, trailing, and space pointing faces and associated mass distributions for the two populations are presented. Author

N91-25003*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
METEOROID AND ORBITAL DEBRIS RECORD OF THE LONG DURATION EXPOSURE FACILITY Abstract Only **c93**
Mike Zolensky, Thomas H. See, Charles G. Simon, Martha K. Allbrooks, and Dale R. Atkinson (POD Associates, Inc., Albuquerque, NM.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 35 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

The Long Duration Exposure Facility (LDEF) was recovered in January 1990 following 5.7 years exposure of approx. 130 square meters of surface area in low-Earth orbit (250-179 miles). Kennedy Space Center acquired data are currently being reduced to yield accurate impact crater depths and diameters. Presented here is a preliminary accounting of the impact record based on the approx. 15.4 square meter surface area of LDEF's 6061-T6 aluminum frame, which was exposed in 26 different directions. Author

N91-25004*# Kent Univ., Canterbury (England). Unit for Space Science.
PARTICULATE IMPACTS ON THE UHCRE COSMIC RAY EXPERIMENT TEFLON COVERS: THE ESA PROGRAMME Abstract Only **c93**
J. A. M. McDonnell, M. T. Paley, T. J. Stevenson, A. Thompson, D. OSullivan, K.-P. Wenzel, and G. H. Schwehm (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 36 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

The optical scanning equipment at the University of Kent Unit for Space Science consists of a 102.5 by 42.5 cm computer controlled motorized stage which has a reproduction accuracy of 30 microns over the entire area. This is used with an optical microscope connected to two charge coupled device video cameras which can be used to obtain stereo color images of any features found. A coordinate system can be defined on each cover by means of two or more reference marks which allow a feature to be located using different equipment such as a scanning electron microscope, providing two known marks can be found. By using back illumination, penetrating features can be found automatically, and their sizes, circularity, and positions logged for later revisiting either on the optical system or using a scanning electron microscope. Author

N91-25005*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PRELIMINARY RESULTS FROM THE CHEMISTRY OF MICROMETEOROID EXPERIMENT (AO 187-1) Abstract Only **c90**
Friedrich Horz, R. P. Bernhard, Thomas H. See, J. Warren, Don E. Brownlee, and M. Laurance (Washington Univ., Seattle.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 37 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

The purpose of experiment AO 187-1 was to expose high purity substrates of suitable cratering properties to obtain detailed crater statistics that may be converted into projectile masses and fluxes and to chemically characterize as many impactors as possible. The latter information would hopefully reveal distinct classes of natural and man-made particles in low-Earth orbit. It was found that crater that yield residues show that natural and man-made impactors may be differentiated and that diversity exists within each group. 'Chondritic' compositions dominate among natural particles, yet some craters contain unmelted fragments of minerals (Olivine and pyroxene). Author

N91-25006*# Washington Univ., Saint Louis, MO. Center for the Space Sciences.
SIMS ANALYSIS OF EXTENDED IMPACT FEATURES ON LDEF EXPERIMENT Abstract Only **c90**
S. Amari, J. Foote, E. K. Jessberger, C. Simon, F. J. Stadermann (Max-Planck-Inst. fuer Kernphysik, Heidelberg, Germany, F.R.), P. Swan, R. Walker, and E. Zinner *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 38 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

Discussed here are the first Secondary Ion Mass Spectroscopy (SIMS) analysis of projectile material deposited in extended impact features on Ge wafers from the trailing edge. Although most capture cells lost their plastic film covers, they contain extended impact features that apparently were produced by high velocity impacts when the plastic foils were still intact. Detailed optical scanning of all bare capture cells from the trailing edge revealed more than 100 impacts. Fifty-eight were selected by scanning electron microscope (SEM) inspection as prime candidates for SIMS analysis. Preliminary SIMS measurements were made on 15

impacts. More than half showed substantial enhancements of Mg, Al, Si, Ca, and Fe in the impact region, indicating micrometeorites as the projectiles. Author

N91-25007*# North Carolina State Univ., Raleigh.
ION MICROPROBE ELEMENTAL ANALYSES OF IMPACT FEATURES ON INTERPLANETARY DUST EXPERIMENT SENSOR SURFACES Abstract Only **c90**
Jerry L. Hunter, Jim J. Wortman, Dieter P. Griffis, and Charles G. Simon (Institute for Space Science and Technology, Inc., Gainesville, FL.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 39 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

Hypervelocity impact features on several of the electro-active dust sensors utilized in the Interplanetary Dust Experiment (IDE) were subjected to elemental analysis using an ion microprobe. The negatively biased dust sensor surfaces acted as ion traps for cations produced in the plasma plumes of impacting particles. Impactor residue surrounds most impact features to two or three feature diameters. After etching away a layer of carbonaceous/silicaceous surface contamination, low mass resolution elemental survey scans are used to tentatively identify the presence of impactor debris. High mass resolution two-dimensional elemental maps and three dimensional depth profiling of the feature and surrounding area show the distribution and relative composition of the debris. The location of these sensors on the six primary Long Duration Exposure Facility (LDEF) sides provides a unique opportunity to further define the debris environment. Researchers applied the same techniques to impact and contaminant features on a set of ultra-pure, highly polished single crystal germanium wafer witness plates that were mounted on row 12 and exposed to the environment during the entire mission. Author

N91-25008*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LDEF IMPACT CRATERS FORMED BY CARBON-RICH IMPACTORS Abstract Only **c90**
T. E. Bunch, F. Radicati diBrozolo, Ronald H. Fleming, David W. Harris, Don E. Brownlee, and Terrence W. Reilly (Hitachi Scientific Instruments, Mountain View, CA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 40 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

Two small craters (number 74, 119 microns, and number 31, 158 microns in diameter) with depth to diameter ratios of about 0.59 and 0.8, respectively, were found in Al from the Long Duration Exposure Facility (LDEF) experiment tray A11E00F). Both craters have residues concentrated in the crater bottoms, along the walls, and on top of the overturned rims. Low voltage scanning electron electron microscopy, Auger electron spectroscopy, time of flight secondary ion mass spectroscopy and energy dispersive x-ray spectroscopy were used to obtain high resolution imagery and elemental analysis. Analyses indicate that the impactor for both craters was carbon-rich, as the residues contain mostly C. Silicon, S, and F in low concentrations are present on the Al surface away from the craters and may be, in part, contaminants.
Author

N91-25009*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IDE SPATIO-TEMPORAL IMPACT FLUXES AND HIGH TIME-RESOLUTION STUDIES OF MULTI-IMPACT EVENTS AND LONG-LIVED DEBRIS CLOUDS Abstract Only **c90**
J. Derral Mulholland, S. Fred Singer, John P. Oliver, Jerry L. Weinberg, William J. Cooke, Philip C. Kassel, Jim J. Wortman, Nancy L. Montague, and William H. Kinard (North Carolina State Univ., Raleigh.) *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 41 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

During the first 12 months of the Long Duration Exposure Facility (LDEF) mission, the Interplanetary Dust Experiment (IDE) recorded over 15,000 total impacts on six orthogonal faces with a time resolution on the order of 15 to 20 seconds. When combined with the orbital data and the stabilized configuration of the spacecraft, this permits a detailed analysis of the micro-particulate environment. The functional status of each of the 459 detectors was monitored every 2.4 hours, and post-flight analyses of these data has now permitted an evaluation of the effective active detection area as a function of time, panel by panel and separately for the two sensitivity levels. Thus, total impacts were transformed into areal fluxes, and are presented here for the first time. Also discussed are possible effects of these fluxes on previously announced results: apparent debris events, meteor stream detections, and beta meteoroids in observationally significant numbers. Author

N91-25010*# Kent Univ., Canterbury (England). Unit for Space Sciences.
DYNAMIC (COMPUTER) MODELLING OF THE PARTICULATE ENVIRONMENT: TRANSFORMATIONS FROM THE LDEF REFERENCE FRAME TO DECODE GEOCENTRIC AND INTERPLANETARY POPULATIONS **c90**
J. A. M. McDonnell and K. Sullivan *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 42 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

The Long Duration Exposure Facility's impact signature record and the size frequency distribution of craters and perforations offers a unique record of environmental data referenced conveniently to the geocentric reference frame. Chemical analysis of residues can offer only limited assistance. Hence, flux modelling has been developed to transform from both geocentric orbital distributions and geocentrically unbounded interplanetary source distributions. This is applied to the foil and crater penetration records in the Ram (E), Trailing (W), and Space Pointing directions to offer the means of decoding the records. It shows that the mix of the components is size dependent. Parametric forms of the modelling transformations are presented for the orbital and unbound populations. Author

N91-25011*# POD Associates, Inc., Albuquerque, NM.
LDEF DATA CORRELATION TO EXISTING NASA DEBRIS ENVIRONMENT MODELS Abstract Only **c90**
Dale R. Atkinson, Martha K. Allbrooks, and Alan J. Watts *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 43 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

Since the Long Duration Exposure Facility was gravity gradient stabilized and did not rotate, the directional dependence of the flux can be easily distinguished. During the deintegration of LDEF, all impact features larger than 0.5 mm into aluminum were documented for diameters and locations. In addition, all diameters and locations of all impact features larger than 0.3 mm into Scheldahl G411500 thermal control blankets were also documented. This data, along with additional information collected from LDEF materials archived at NASA Johnson Space Center (JSC) on smaller features, will be compared with current meteoroid and debris models. This comparison will provide a validation of the models and will identify discrepancies between the models and the data. Author

N91-25012*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DERIVING THE VELOCITY DISTRIBUTION OF METEOROIDS FROM THE MEASURED METEOROID IMPACT DIRECTIONALITY ON THE VARIOUS LDEF SURFACES Abstract Only **c90**
Herbert A. Zook *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 44 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

Because of spacecraft motion, a much higher flux of meteoroids

is expected to strike the leading (apex) surface of a spacecraft than is expected to strike the trailing (antapex) surface. The ratio of fluxes (apex to antapex) depends on the velocity distribution of meteoroids entering the Earth's atmosphere. The ratio ranges from 5.7 to 9.2 at constant meteoroid mass for the three velocity distributions examined. The velocity of impact is also greater, on average, on the apex surface than on the antapex surface, and the impacts tend to be more normal to the surface. This means that the meteoroids that make a crater of a given diameter are less massive than those that strike the antapex surface. These effects further increase the apex-antapex abundance ratio at constant crater diameter compared to that at constant mass. For craters 100 microns in diameter on 6061 T6 aluminum on the Long Duration Exposure Facility, the ratios obtained on various surfaces are given in tabular form. Author

N91-25013*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
M AND D SIG PROGRESS REPORT: LABORATORY SIMULATIONS OF LDEF IMPACT FEATURES Abstract Only **c90**

Friedrich Horz, R. P. Bernhard, Thomas H. See, Dale R. Atkinson, and Martha K. Allbrooks (POD Associates, Inc., Albuquerque, NM.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 45 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

Reported here are impact simulations into pure Teflon and aluminum targets. These experiments will allow first order interpretations of impact features on the Long Duration Exposure Facility (LDEF), and they will serve as guides for dedicated experiments that employ the real LDEF blankets, both unexposed and exposed, for a refined understanding of the Long Duration Exposure Facility's collisional environment. Author

N91-25014*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PRELIMINARY MICROMETEOROID AND DEBRIS EFFECTS ON LDEF THERMAL CONTROL SURFACES Abstract Only **c90**

Martha K. Allbrooks, Dale R. Atkinson, Thomas H. See (Lockheed Engineering and Sciences Co., Houston, TX.), and Friedrich Horz *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 45b (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

Thermal control surfaces on the Long Duration Exposure Facility (LDEF) were exposed to 5.75 years of low-Earth orbit environments. Since LDEF was gravity gradient stabilized and directionally stable, the effects of each of the environments can be distinguished via changes in material responses to hypervelocity impacts. The extent of these effects are being visually and microscopically characterized using thermal control surfaces archived at Johnson Space Center in order to determine the the relationship between environment exposure and resulting ring sizes, delamination areas, and penetration diameters. The characterization of these affected areas will provide spacecraft system designers with the information they require to determine degradation of thermal control systems during satellite lifetimes. Author

N91-25015*# Utah State Univ., Logan. Dept. of Physics.
THE INTERSTELLAR GAS EXPERIMENT (IGE) Abstract Only **c90**

Don Lind *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 47 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 03B

The Interstellar Gas Experiment (IGE) exposed thin metallic foils in order to collect neutral particles from the interstellar gas. These particles were entrapped in the foils along with precipitating magnetospheric and ambient atmospheric particles. Seven of these foils collected particles arriving from seven different directions as seen from the spacecraft for the entire duration of the Long Duration Exposure Facility (LDEF) mission. The authors' mass spectroscopy analysis of the noble gas component of these interstellar particles detected isotopes of helium and neon. These preliminary measurements suggest that the various isotopes are occurring in approximately the expected amounts and that their distribution in direction of arrival is close to what models predict. The analysis to subtract the background fluxes of magnetospheric and atmospheric particles is still in progress. The hope of this experiment is to investigate the noble gas isotopic ratios of this interstellar sample of matter which originated outside the solar system. Author

N91-25016*# Boeing Aerospace and Electronics Co., Seattle, WA.
ATOMIC OXYGEN AND ULTRAVIOLET RADIATION MISSION TOTAL EXPOSURES FOR LDEF EXPERIMENTS Abstract Only **c72**

R. J. Bourassa, J. R. Gillis, and Ken W. Rousslang *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 48 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

An analytical treatment of the effect of thermal molecular velocity on spacecraft atomic oxygen (AO) flux is presented. The analysis leads to a closed form equation that incorporates the effect of atmospheric temperature, number density, spacecraft velocity, and incidence angle on AO flux. The effects of atmospheric rotation, solar activity, and geomagnetic index on AO flux are also included on the computer model. Data developed with the model are presented for the Long Duration Exposure Facility (LDEF). The results incorporate variations in the defining environmental and orbital parameters of the spacecraft over its six year orbital flight. Cumulative ultraviolet solar and albedo exposures were calculated . Author

N91-25017*# Army Materials Technology Lab., Watertown, MA.
MEASUREMENT OF THE O18 TO O16 ISOTOPE RATIO FOR CHARACTERIZING OXIDE SURFACE LAYERS ON LDEF SAMPLES Abstract Only **c72**

Paul L. Sagalyn *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 49 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

Calculations indicate that measurement of the O-16 to O-18 isotope ratio in oxide layers formed on the surfaces of the Long Duration Exposure Facility (LDEF) samples would provide a powerful tool for distinguishing between layers formed at high altitudes and layers formed at low altitudes, as for example during the retrieval of a satellite. In principle, this ratio may be used to date the formation of the oxide layers. Author

N91-25018*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PRELIMINARY FINDINGS OF THE LDEF MATERIALS SPECIAL INVESTIGATION GROUP Abstract Only **c27**

Bland A. Stein and H. Gary Pippin (Boeing Aerospace Co., Seattle, WA.) *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 51 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Presented here are the charter and scope of the Long Duration Exposure Facility's (LDEF) Space Environmental Effects on Materials Special Investigation Group (MSIG) activities, and an overview of of preliminary observations. These observations of low-Earth orbit environmental effects on material were made in space during during LDEF retrieval and during LDEF tray deintegration. Also included are initial findings of laboratory analysis of LDEF materials. Author

N91-25019*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CHEMICAL CHARACTERIZATION OF SELECTED LDEF POLYMERIC MATERIALS Abstract Only **c27**

Philip R. Young and Wayne S. Slemp *In its* First LDEF

Post-Retrieval Symposium Abstracts Jun. 1991 p 52 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Chemical characterization of selected polymeric materials which received exposure on the Long Duration Exposure Facility (LDEF) is reported. The specimens examined include silvered fluorinated ethylene propylene Teflon thermal blanket material, polysulfone, epoxy, polyimide matrix resin/graphite fiber reinforced composites, and several high performance polymer films. These specimens came from numerous LDEF locations, and thus received different environmental exposures. The results to date show no significant change at the molecular level in the polymer that survived exposure. Scanning electron and scanning tunneling microscopes show resin loss and a texturing of some specimens which resulted in a change in optical properties. The potential effect of a silicon-containing molecular contamination on these materials is addressed. The possibility of continued post-exposure degradation of some polymeric films is also proposed. Author

N91-25020*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
PRELIMINARY INVESTIGATION OF THIN FILM POLYMERS EXPOSED TO LOW EARTH ORBIT Abstract Only **c27**
Thomas Strganac, Allan Farrow, and Alan Letton *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 53 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Preliminary results of thin film polymers exposed to low-Earth orbit aboard the Long Duration Exposure Facility (LDEF) are discussed. Dynamic testing of a 0.92/0.92 mil. polyester laminate film indicated that the modulus loss of the exposed specimens may be very small. When the storage modulus of the exposed specimen was compared to the storage modulus of a control specimen over a temperature range of minus 150 degrees to 100 degrees, there was very little change. Fourier Transform Spectroscopy performed on the same exposed material indicated crosslinking of the polyethylene, which was verified by an increase in the storage modulus above the glass transition temperature. Optical microscopy of the sample showed micrometeoroid strikes and contamination in spots by what is thought to be silicon outgassed from a nearby experiment. Author

N91-25021*# Texas A&M Univ., College Station. Polymer Science and Engineering Program.
STUDY OF BALLOON AND THERMAL CONTROL MATERIAL DEGRADATION ABOARD LDEF Abstract Only **c27**
Alan Letton, Neil I. Rock, Kevin D. Williams, and Thomas Strganac *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 54 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The initial results of analysis performed on a number of polymeric materials which were exposed aboard the Long Duration Exposure Facility (LDEF) are discussed. These materials include two typical high altitude balloon films (a polyester and a polyethylene) and silver-backed Teflon from thermal control blanket samples. The techniques used for characterizing changes in mechanical properties, chemical structure and surface morphology include Fourier Transform Infrared (FTIR) spectroscopy, scanning electron microscopy, and dynamic mechanical analysis. Author

N91-25022*# Texas A&M Univ., College Station. Polymer Science and Engineering Program.
THE INFLUENCE OF FLOWING AFTERGLOW EXPOSURE ON THE DEGRADATION OF VARIOUS POLYMERIC MATERIALS Abstract Only **c27**
Alan Letton, Neil I. Rock, and Kevin D. Williams *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 55 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Changes in polymer properties which result after exposure to an atomic oxygen-rich environment of a flowing afterglow are presented. Dynamic mechanical and Fourier Transform Infrared (FTIR) spectra as well as scanning electron microscopy micrographs were employed to monitor variations in mechanical properties and chemical and physical structure. Polymers analyzed include polystyrene, PEKK, and a polyester. Author

N91-25023*# Alabama Univ., Huntsville.
CHEMICAL ANALYSIS OF METAL AND POLYMER SURFACES ON THE FRONT AND REAR LDEF Abstract Only **c27**
L. Christi, John C. Gregory, G. N. Raikar, J. J. Weimer, and R. Wiser *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 56 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The University of Alabama in Huntsville experiment AO114 contained 128 solid surface samples, half of which were exposed on the front and half on the rear of the Long Duration Exposure Facility (LDEF). Each sample is being subject to a battery of analysis methods. In poster form, details of the x-ray photoelectron spectra, Auger electron spectra, Fourier Transform Infrared and ATR infrared spectra, high resolution profilometry, and scanning electron microscope imagery will be presented from a selection of metal and non-metal surfaces. Author

N91-25024*# TRW Space and Defense Sector, Redondo Beach, CA.
LEO SPACE ENVIRONMENTAL EFFECTS: TRW LDEF EXPERIMENTAL TRAYS Abstract Only **c25**
B. K. Blakkolb, J. Y. Yaung, L. E. Ryan, and W. Taylor *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 57 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 07D

Comprised of two identical trays, the TRW Long Duration Exposure Facility (LDEF) experiment (A0054) provided a unique opportunity to study long term space environmental effects on a variety of materials exposed to two different space environments. The leading edge tray saw micrometeors and anthropogenic space debris, ultraviolet radiation, and energetic atomic oxygen. In contrast, the trailing edge tray was exposed to ultraviolet and micrometeors but saw relatively little, if any, space debris fluence and no energetic atomic oxygen. The striking difference in appearance of the two experimental trays is directly attributable to the nonuniformity of the space environment about the LDEF. It is estimated that the majority of the erosion to the Kapton polyimide dielectric material occurred during the last month on orbit due to the sharply nonlinear increase in atomic oxygen number density as orbital altitude decayed over the life of the mission. Author

N91-25025*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
INTERACTIONS OF ATOMIC OXYGEN WITH MATERIAL SURFACES IN LOW EARTH ORBIT: PRELIMINARY RESULTS FROM EXPERIMENT A0114 Abstract Only **c25**
John C. Gregory, L. Christl, G. N. Raikar, J. J. Weimer, R. Wiser (Alabama Univ., Huntsville.), and P. N. Peters *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 58 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 07D

The University of Alabama at Huntsville atomic oxygen experiment consisted of two trays of 64 one inch diameter solid samples. One tray was placed on the leading edge and one on the trailing edge of the spacecraft. Half of each sample was covered to provide a control. Thus it was intended that the effects of atomic oxygen and solar ultraviolet radiation on the surface properties of each material could be distinguised from each other and from the effects of aging. Sixteen of the samples were placed on a thermally isolated plate of highly polished aluminum, while the main plate was coated with the thermal control coating S13-GLO. Though the experiment was entirely passive, it was hoped that the effects of thermal activation might be observed, if

present. The plates were expected to stabilize at temperatures differing by 20 to 30 C. The experiment also carried a device to measure the spacecraft altitude and several oxygen atom reflectometers which have not been analyzed to date. The samples included thin films of metals Os, Ir, Pt, Ni, W, Mo, and Al coated onto fused silica optical flats; metal carbides (WC, SiC), solid carbons of various types, eight polymers and some other coatings of various types. Author

N91-25026*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ATOMIC OXYGEN STIMULATED OUTGASSING Abstract Only **c27**
Roger C. Linton and John M. Reynolds *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 59 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The passive Long Duration Exposure Facility (LDEF) Experiment A0034, Atomic Oxygen Simulated Outgassing, consisted of two identical one-sixth tray modules, exposing selected thermal control coatings to atomic oxygen and the combined space environment on the leading edge and, for reference, to the relative wake environment on the trailing edge. Optical mirrors were included adjacent to the thermal coatings for deposition of outgassing products. Ultraviolet grade windows and metal covers were provided for additional assessment of the effects of the various environmental factors. Preliminary results indicate that orbital atomic oxygen is both a degrading and a optically restorative factor in the thermo-optical properties of selected thermal coatings. There is evidence of more severe optical degradation on collector mirrors adjacent to coatings that were exposed to the RAM-impinging atomic oxygen. This evidence of atomic oxygen stimulated outgassing is discussed in relation to alternative factors that could affect degradation. The general effects of the space environment on the experiment hardware as well as the specimens are discussed. Author

N91-25027*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ATOMIC OXYGEN UNDERCUTTING OF LDEF ALUMINIZED KAPTON MULTILAYER INSULATION Abstract Only **c72**
Kim K. deGroh *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 60 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20H

Atomic oxygen undercutting is a potential threat to vulnerable spacecraft materials which have been shielded with an atomic oxygen protective coating. This is due to atomic oxygen attack of oxidizable materials at the point of microscopic defects in the protective coatings which occur during fabrication and handling, or from micrometeoroid and debris bombardment in space. An aluminized Kapton multilayer insulation sample which was flown on the leading edge of the Long Duration Exposure Facility (LDEF) was used to study low Earth orbit (LEO) directed ram oxygen undercutting. Cracks in the aluminized coatings around the vent holes provided excellent locations for evaluation of atomic oxygen undercutting. The undercutting profiles were compared to Monte Carlo models which predict LEO ram atomic oxygen attack. The shape of the undercurrent profile was found to vary with crack width, which is proportional to the number of atomic oxygen atoms entering the crack. The resulting atomic oxygen undercut profiles which occurred on LDEF indicated wide undercut cavities in spite of the fixed ram orientation. Potential causes of the observed undercutting profiles will be presented. Implications of the undercutting profiles relevant to Space Station Freedom will also be discussed. Author

N91-25028*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
PRELIMINARY RESULTS FOR LDEF/HEPP THERMAL CONTROL SAMPLES Abstract Only **c27**
Lon Kauder *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 61 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Sixty-five one inch by twelve inch strips of Kapton coated with various black paints, clear coatings, and thin film oxides were placed at three locations on the Long Duration Exposure Facility. Two sets were flown in the ram direction on top of the MLI blanket of the Cascade Variable Conductance Heat Pipe Experiment. Two other sets were flown on top of the MLI blanket of the Low Temperature Heat Pipe Experiment perpendicular to the ram direction. The last thirteen samples were taped to the perimeter of the HEPP power tray on the space end of the satellite. The solar absorptance and normal emittance measurements made on the 52 remaining samples are presented, as well as data on the above mentioned samples. Author

N91-25029*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ATOMIC OXYGEN INTERACTIONS WITH FEP TEFLON AND SILICONES ON LDEF Abstract Only **c27**
Bruce A. Banks and Linda Gebauer (Cleveland State Univ., OH.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 62 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The Long Duration Exposure Facility (LDEF) spacecraft represents the first controlled unidirectional exposure of high-fluence atomic oxygen on fluorinated ethylene propylene (FEP Teflon) and silicones. The atomic oxygen erosion yield for FEP Teflon was found to be significantly in excess of previous low fluence orbital data and is an order of magnitude below that of polyimide Kapton. LDEF FEP Teflon erosion yield data as a function of angle of attack is presented. Atomic oxygen interaction with silicon polymers results in crazing of the silicones as well as deposition of dark contaminant oxidation products on adjoining surfaces. Documentation of results and possible mechanistic explanations are presented. Author

N91-25030*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
VUV-INDUCED DEGRADATION OF FEP TEFLON ABOARD LDEF Abstract Only **c27**
David E. Brinza, Ranty H. Liang, and Albert E. Stiegman *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 63 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Examination of fluorinated ethylene propylene (FEP) copolymer materials recovered from the Long Duration Exposure Facility (LDEF) reveals differing damage characteristics on leading edge (ram-facing) versus trailing edge (wake-facing surfaces). Silver/Teflon (Ag/FEP) thermal control materials on ram facing surfaces of the LDEF exhibited obvious degradation, with an apparent increase in diffuse light scattering, whereas identical materials on the wake facing surfaces showed little apparent damage with cursory inspection. Microscopic examination of both types of surfaces reveals the nature and extent of environment induced degradation of materials. The ram facing surfaces were clearly eroded by atomic oxygen impingement, while the wake facing material developed a thin, highly embrittled surface layer. Author

N91-25031*# Aerospace Corp., El Segundo, CA.
SPACE ENVIRONMENTAL EFFECTS ON SILVERED TEFLON THERMAL CONTROL SURFACES Abstract only **c27**
C. S. Hemminger, W. K. Stuckey, and J. C. Uht *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 64 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Cumulative space environment effects on Ag/fluorinated ethylene propylene (FEP) were a function of exposure orientation. Samples from nineteen silvered Teflon (Ag/FEP) thermal control

surfaces recovered from the Long Duration Exposure Facility (LDEF) were analyzed to determine changes in this material as a function of position on the spacecraft. Although solar absorptance and infrared emittance of measured thermal blanket specimens are relatively unchanged from control specimen values, significant changes in surface morphology, composition and chemistry were observed. Researchers hypothesize that the FEP surfaces on LDEF were degraded by ultraviolet radiation exposure at all orientations, but that the damaged material had been removed by erosion from the blankets exposed to atomic oxygen flux and that contamination is masking the damage on trays flanking the trailing edge.
Author

N91-25032*# Boeing Aerospace and Electronics Co., Seattle, WA.
RESULTS OF EXAMINATION OF SILVERED TEFLON FROM THE LONG DURATION EXPOSURE FACILITY Abstract Only **c27**
Ken W. Rousslang, E. Russ Crutcher, and H. Gary Pippin *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 65 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Pieces of silvered Teflon thermal control blanket from seventeen locations on the Long Duration Exposure Facility (LDEF) were studied. Results of the measurements of surface texturing, and mechanical, electrical and thermal properties are presented. Photos of the blankets, scanning electron microscope pictures, infrared spectra, and surface analysis results are presented. Contamination issues relative to performance of the blankets are discussed. The variation in measured properties are reported as a function of exposure conditions.
Author

N91-25033*# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
PRELIMINARY INVESTIGATIONS INTO UHCRE THERMAL CONTROL MATERIALS Abstract Only **c27**
Francois Levadou, Mike Froggatt, Martin Rott, and Eberhard Schneider (Fraunhofer Inst. fuer Kurzzeitdynamik, Freiburg im Breisgau, Germany, F.R.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 66 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

An overview is given of the initial work which has been done in the European Space Research and Technology Center (ESTEC) Materials and Processes Division to evaluate the effect of space environment on the thermal blankets of the Ultra-Heavy Cosmic Ray Nuclei Experiment (UHCRE). Also, an account is given of the simulation of the impacts of micrometeoroids and space debris in a spare flight thermal blanket by means of plasma gun and light gas gun acceleration facilities.
Author

N91-25034*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF LDEF FLIGHT EXPOSURE ON SELECTED POLYMERIC FILMS AND THERMAL CONTROL COATINGS Abstract Only **c27**
Wayne S. Slemp, Philip R. Young, and James Y. Shen (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 67 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The characterization of polymeric films and thermal control coatings which were exposed for five years and ten months to the low-Earth environment is reported. Changes in solar absorptance, thermal emittance, and transmission are compared to laboratory control specimens. Sputter-deposited metallic coatings are shown to eliminate atomic oxygen erosion of resin matrix composite materials. The effects of long-term atomic oxygen exposure to metallized FEP Teflon film is characterized. Chemical characterization of polymeric films indicates that although surface erosion occurs, the molecular structure of the basic polymeric film has not changed significantly in response to this exposure.
Author

N91-25035*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THERMAL CONTROL SURFACES EXPERIMENT (S0069) INITIAL MATERIALS EVALUATION Abstract Only **c27**
Donald R. Wilkes, Leigh L. Hummer, M. John Brown (AZ Technology, Huntsville, AL.), and James M. Zwiener *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 68 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The behavior of materials in the space environment and our understanding of this behavior continues to be a limiting technology for spacecraft and experiments. The Thermal Control Surfaces Experiment (TCSE) aboard the Long Duration Exposure Facility (LDEF) is the most comprehensive experiment flown to study the effects of the space environment on thermal control surfaces. Selected thermal control surfaces were exposed to the LDEF orbital environment and the effects of this exposure measured. The TCSE combined in-space optical measurements with pre- and post-flight analyses of flight materials to determine the effects of long term space exposure. Many of the samples underwent significant changes in appearance as well as optical and mechanical properties.
Author

N91-25036*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
UNUSUAL MATERIALS EFFECTS OBSERVED ON THE THERMAL CONTROL SURFACES EXPERIMENT (S0069) Abstract Only **c27**
James M. Zwiener, Donald R. Wilkes, and Leigh L. Hummer (AZ Technology, Huntsville, AL.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 69 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

A number of unusual effects were observed on the Thermal Control Surface Experiment (TCSE) test samples, front cover, and structural components. These include induced UV fluorescence, the migration and degradation of KRS-5 materials, atomic oxygen effects, contamination, texturing, discoloration, and meteoroid/debris impact. LDEF (Long Duration Exposure Facility) mission induced fluorescence was observed on several TCSE samples. Similar fluorescence was observed on LDEF leading edge materials from Experiment A0114.
Author

N91-25037*# Centre d'Etudes et de Recherches, Toulouse (France).
SPACECRAFT THERMAL CONTROL COATINGS (AO 138-6) Abstract Only **c27**
Alain Paillous and Jean Claude Guillaumon (Centre National d'Etudes Spatiales, Toulouse, France) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 70 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The experiment A0 138-6 was located on the trailing edge of LDEF as part of the Experiment FRECOPA. Material specimens 2 x 2 cm, independently mounted in sample-holders with their surface in the same reference plane, were exposed to space. Materials include paints (conductive or not), SSMs, polymeric films, surface coatings, composite materials, and metals. The results show that for some materials the degradation was higher for samples in the canister than for those directly mounted on the tray; contamination problems were ruled out, the higher temperature experienced by the samples inside the canister probably explains this phenomenon.
Author

N91-25038*# Dayton Univ., OH.
THERMAL CONTROL MATERIALS Abstract Only **c27**
C. Hurley *In* NASA, Langley Research Center, First LDEF

Post-Retrieval Symposium Abstracts Jun. 1991 p 71 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The LDEF M0003-5 Thermal Control Materials Experiment contains numerous thermal control coatings, metallized and nonmetallized polymeric films, adhesives, OSR's, and metallic foils. The materials were located on the leading and trailing edges of the satellite, therefore exposed to two different low earth orbital environments. Many specimens received a total exposure of 5.75 years and other received a limited exposure of 0.9 years to the complete environment. On-orbit and post flight photographic records are presented. The material's physical and optical performance are discussed as a function of location and duration of exposure. Data concerning specimen condition, degradation, contamination, optical reflectance and transmittance are discussed. The effect of atomic oxygen erosion on specific materials is also presented, The performance of adhesive bonds with polymeric films is reviewed. Author

N91-25039*# Boeing Aerospace and Electronics Co., Seattle, WA.
RESULTS OF EXAMINATION OF THE A-276 WHITE AND Z-306 BLACK THERMAL CONTROL PAINT DISCS FLOWN ON LDEF Abstract Only **c27**
Johnny L. Golden *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 72 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Measurements of optical properties and surface characterization of paint discs on selected tray clamps were carried out and are reported. Analysis shows the loss of organic binder for those specimens exposed to atomic oxygen. A visibly darkened layer up to 2 microns thick exists on the outer surfaces of specimens exposed only to solar radiation. Properties of ground control specimens and flight control specimens, as a function of spacecraft location are reported. Representative examples from a photomicrograph survey and SEM examination are shown. Author

N91-25040*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ION BEAM TEXTURED AND COATED SURFACES EXPERIMENT (IBEX) Abstract Only **c27**
Michael J. Mirtich, Nicholas Stevens, and James Merrow (Cleveland State Univ., OH.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 73 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The IBEX, with 36 samples of various materials, was placed aboard the LDEF. Twenty-seven of the samples had surfaces modified using ion beam technology, and nine were made up of commercially available materials. The materials are in some way useful in space power systems. The various types of materials tested included six categories: (1) ion beam structured surfaces suitable for solar thermal (concentrator) or space radiators; (2) ion beam sputtered conductive coatings for thermal and space charge control; (3) solar reflector surfaces; (4) flexible thin film coatings and solar array blanket material for protection of spacecraft polymers; (5) painted and/or state-of-the-art solar thermal materials; and (6) micrometeoroid sensitive detector. Data analysis presented include the optical properties of each surface before and after exposure to the space environment and the respective backup surfaces. Author

N91-25041*# Army Materials Technology Lab., Watertown, MA.
ELLIPSOMETRIC STUDY OF METAL SAMPLES Abstract Only **c26**
W. Franzen, Judy Brodkin, and Paul L. Sagalyn *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 74 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11F

Exposed and unexposed (shielded) portions of the surfaces of six different metal samples (Al, Cu, Ni, Ta, W, and Zr) that had been mounted on LDEF were studied by variable angle spectroscopic ellipsometry. The change in the optical constants of the metals caused by exposure to the space environment was measured. The measured optical constants reflect changes in the morphology and stoichiometry of a surface layer to a depth of this order of magnitude. For all the samples examined in this manner the exposed and unexposed portions exhibited dramatically different optical properties. In order to determine whether the observed changes were caused by the impact of oxygen atoms encountered in flight an experiment was set up in which samples identical to the original metal samples are exposed to a low-energy oxygen plasma in a microwave discharge chamber. Results of this experiment are reported, as well as an analysis of the observed data in terms of surface layers of different composition. Author

N91-25042*# Boeing Aerospace and Electronics Co., Seattle, WA.
CONDITION OF CHROMIC ACID ANODIZED ALUMINUM CLAMPS FLOWN Abstract Only **c26**
W. L. Plagemann *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 75 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11F

A survey of the condition of the chromic acid anodized (CAA) coating on selected LDEF tray clamps was carried out. Measurements of solar absorptance and thermal emittance were carried out at multiple locations on both the space exposed and spacecraft facing sides of the clamps. Multiple clamps from each available angle relative to the ram direction were examined. The diffuse component of the reflectance spectrum was measured for a selected subset of the clamps. The thickness of the CAA was determined for a small set of clamps. Examples of variation in integrity of the coatings from leading to trailing edge will be shown. Author

N91-25043*# Air Force Geophysics Lab., Hanscom AFB, MA. Space Physics Div.
PATTERNS OF DISCOLORATION AND OXIDATION BY DIRECT AND SCATTERED FLUXES, ESPECIALLY OXYGEN ON SILICON Abstract Only **c27**
A. R. Frederickson, R. C. Filz, F. J. Rich, and Paul L. Sagalyn (Army Materials Technology Lab., Watertown, MA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 76 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

A number of interesting discoloration patterns are clearly evident on M0002-1 which resides on three faces of LDEF: front face, rear face, and earth face. Most interesting is the pattern of blue oxidation on polished single crystal silicon apparently produced by once-scattered ram oxygen atoms along the earth face. Most of the other patterns are seen in the Thermal Control Paint. Also, severe oxidation of CR-39 polycarbonate occurred on the front face of LDEF, as expected. A complete explanation for the patterns has not yet been obtained. Author

N91-25044*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
THERMAL-VACUUM EFFECTS ON POLYMER MATRIX COMPOSITE MATERIALS Abstract Only **c27**
R. C. Tennyson and G. E. Mabson *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 77 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Results are presented on the thermal-vacuum response of a variety of fiber reinforced polymers matrix composites that comprised the UTIAS experiment on the LDEF satellite. Theoretical temperature-time predictions for this experiment are in excellent agreement with test data. Results also show quite clearly the effect of outgassing in the dimensional changes of these materials and the corresponding coefficients of thermal expansion. Finally,

comparison with ground-based simulation tests are presented as well. Use of these data for design purposes are also given.
Author

N91-25045*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
ATOMIC OXYGEN EROSION OF POLYMER MATRIX COMPOSITES Abstract Only **c27**
R. C. Tennyson, J. Kleiman, and W. D. Morison *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 78 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Results are presented on atomic oxygen erosion of circular tubes and flat plates fabricated from different epoxy matrix composites containing, boron and Kevlar fiber reinforcements. The UTIAS experiment was located at station D-12, at 90 deg to the LDEF leading edge which was yawed about approximately 8 to 10 deg relative to the velocity vector. This resulted in enhanced atomic oxygen exposure at D-12, providing a total fluence of about 4 x 10(exp 20) atoms/sq cm. Thickness loss measurements were obtained for both flat plates and cylindrical tubes. The effect of reflected atomic oxygen on erosion yield and surface morphology on back surfaces (not directly exposed to AO) are graphically demonstrated. Erosion yields are also compared with other space flight data for similar materials, and ground-based tests in the UTIAS AO simulator. The effect of angle of incidence on surface morphology, erosion profiles and thickness losses are presented and the results correlated with simulator tests as well. Author

N91-25046*# Aerospace Corp., El Segundo, CA.
LONG DURATION EXPOSURE FACILITY EXPERIMENT M0003 DEINTEGRATION/FINDINGS AND IMPACTS Abstract Only **c27**
M. J. Meshishnek, S. R. Gyetvay, and C. H. Jaggers *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 79 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The Aerospace Corporation LDEF Experiment M0003 was designed to study the effect of the space environment on a large variety of spacecraft materials and components, both current and developmental. The experiment was housed in four LDEF trays and contained over 1200 specimens, two data systems, and two environment exposure control canisters. Effects of the space environment such as vacuum, ultraviolet, atomic oxygen, meteoroid and debris, thermal cycling and synergistic effects on various samples are described, and summaries of the board data are presented. Author

N91-25047*# Aerospace Corp., El Segundo, CA.
LONG DURATION EXPOSURE FACILITY EXPERIMENT M0003 DEINTEGRATION OBSERVATIONS Abstract Only **c27**
S. R. Gyetvay, Laana Fishman, and M. J. Meshishnek *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 80 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The four trays of the M0003 materials experiment on LDEF contained over 1200 test articles from 19 subexperiments. The complete tests article complement represented a broad range of materials, including thin film optical coatings, paints, polymer sheets and tapes, adhesives, and composites, for use in various spacecraft applications including thermal control, structures, optics, and solar power. All of the test articles were examined individually using bright field, dark field, and Nomarski light microscopy techniques. The condition of the test articles were photo-documented and observed global and anomalous effects were recorded for the benefit of the subexperimenters. Author

N91-25048*# Boeing Aerospace and Electronics Co., Seattle, WA.
SURVEY OF RESULTS FROM THE BOEING MODULES ON THE M0003 EXPERIMENT ON LDEF Abstract Only **c27**
H. Gary Pippin, Owen Mulkey, Juris Verzemnieks, Emmett Miller, Sylvester G. Hill, and Harry Dursch *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 81 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The Boeing modules on the M0003 experiment included fiber optics, ceramic materials, a variety of electronic piece parts, composites and thermal control paints, fasteners, thin film lubricants, anodized surfaces, and adhesives. These materials were flown on the leading and trailing edge exteriors, and on the interior portion of LDEF M0003 providing exposure under three distinct environments. The condition of each of these material types is described. Results of optical, surface, and mechanical properties are presented. Author

N91-25049*# Aerospace Corp., El Segundo, CA.
EXPERIMENT M0003-10: ADVANCED COMPOSITES Abstract Only **c24**
Gary L. Steckel and Tuyen D. Le *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 82 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

The Advanced composites Sub-experiment includes numerous metal matrix composites, primarily graphite fiber reinforced aluminum and magnesium, and several classes of graphite fiber reinforced organic matrix (epoxy, polysulfone, polyimide) composites with and/or without thermal control or protective coatings. The experiment included over 500 flight samples, mounted on the leading and trailing edges of LDEF, and a full complement of the laboratory control samples. Preliminary results are presented reviewing changes in the visual appearance of the samples, atomic oxygen erosion of the organic matrix composites, contamination effects, and the effects of micrometeorite impacts and thermal fatigue on the metal matrix composites. Author

N91-25050*# Boeing Aerospace and Electronics Co., Seattle, WA.
RESULTS FROM ANALYSIS OF BOEING COMPOSITE SPECIMENS FLOWN ON LDEF EXPERIMENT M0003 Abstract Only **c24**
Sylvester G. Hill, Pete George, E. Russ Crutcher, Harry Dursch, and H. Gary Pippin *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 83 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

Specimens of three selected organic/graphite fiber composite materials were flown on both the leading and trailing edges of LDEF. Additional sets of compression, tension, flexure, and lap shear specimens were flown on the trailing edge. A large T300/934 panel was flown on the leading edge. One quarter of this specimen was directly exposed to a near ram environment; each of the other three quarters were covered with a different thermal control paint. Results of mechanical, optical, and chemical analysis of the specimens are presented. Recession rates of the fiber and resin under atomic oxygen exposure were estimated and are reported.
Author

N91-25051*# Lockheed Missiles and Space Co., Sunnyvale, CA.
LDEF-SPACE ENVIRONMENTAL EFFECTS ON MATERIALS: COMPOSITES AND SILICONE COATINGS Abstract Only **c24**
Brian C. Petrie *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 84 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

The objective of the Lockheed experiment is to evaluate the effects of long term low Earth orbit environments on thermal control coatings and organic matrix/fiber reinforced composites. Two diverse categories are reported: silicone coatings and composites.

For composites physical and structural properties were analyzed; results are reported on mass/dimensional loss, microcracking, short beam shear, CTE, and flexural properties. The changes in thermal control properties, mass, and surface chemistry and morphology are reported and analyzed for the silicon coatings. Author

N91-25052*# Michigan Univ., Ann Arbor.
HIGH-TOUGHNESS GRAPHITE/EPOXY COMPOSITE MATERIAL EXPERIMENT Abstract Only **c24**
David K. Felbeck *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 85 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

The experiment was designed to measure the effect of near-space exposure on mechanical properties of specially toughened 5208/T300 graphite-epoxy composites. The properties measured are elastic modulus, strength, and fracture toughness. Specimens were mounted on an external frame during the time of the LDEF mission. Specimen variables include angle of adjacent plies and fraction of interlaminar contact, which is controlled by the fraction of finely spaced holes in Mylar film placed between the prepreg monolayers of the composite. Author

N91-25053*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF LDEF FLIGHT EXPOSURE ON SELECTED POLYMER MATRIX RESIN COMPOSITE MATERIALS Abstract Only **c24**
Wayne S. Slemp, Philip R. Young, William G. Witte, Jr., and James Y. Shen (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 86 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

The characterization of selected graphite fiber reinforced epoxy and polysulfone matrix resin composites which received exposure to the LEO environment on the LDEF is reported. The changes in mechanical properties of ultimate tensile strength and tensile modulus for exposed flight specimens are compared to the three sets of control specimens. Marked changes in surface appearance are discussed, and resin loss is reported. The chemical characterization including IR, thermal, and selected solution property measurements showed that the molecular structure of the polymeric matrix had not changed significantly in response to this exposure. Author

N91-25054*# Aerospatiale, Les Mureaux (France).
EFFECT OF SPACE ENVIRONMENT ON COMPOSITE MATERIALS AND THERMAL COATINGS (AO 138-9) Abstract Only **c24**
Michel Parcelier *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 87 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

The results are presented of experiments located in one of FRECOPA canister on epoxy-matrix carbon fiber reinforced composite materials, adhesives, and thermal coatings. Only thermal coatings and some composite materials were exposed to direct space environment for the first year, while other materials (for mechanical and expansion tests) were located in the lower levels (subjected to only vacuum and thermal cycling). In order to assess the degradation of materials after space aging, reference specimens were stored in clean room for the duration of LDEF mission and tested at the same time as the aged specimens. Author

N91-25055*# MATRA Espace, Toulouse (France).
EFFECT OF SPACE EXPOSURE OF SOME EPOXY MATRIX COMPOSITES ON THEIR THERMAL EXPANSION AND MECHANICAL PROPERTIES (AO 138-8) Abstract Only **c24**
Heinrich Jabs *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 88 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

The experiment objectives are: to detect a variation of the coefficient of thermal expansion (CTE) of composite samples; to detect an evolution of mechanical properties; to compare the behavior of two epoxy resins. The CTE is measured by interferometric method in a vacuum chamber. The following mechanical tests are achieved on the samples: interlaminar shear strength; flexural strength; flatwise tensile strength. The results are reported. Author

N91-25056*# Rockwell International Corp., Tulsa, OK.
EVALUATION OF LONG-DURATION EXPOSURE TO THE NATURAL SPACE ENVIRONMENT ON GRAPHITE-POLYIMIDE AND GRAPHITE-EPOXY MECHANICAL PROPERTIES Abstract Only **c24**
Richard F. Vyhnal, Douglas W. Welch, and Howard J. Powell *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 89 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11D

Experiment AO175 involved passive exposure (on oblique leading and trailing faces of LDEF) of carbon-fiber reinforced laminates of epoxy, bismaleimide, and polyimide resins. Post-flight evaluation included: optical examination of exposed surfaces, panel weight and distortion measurements, ultrasonic c-scan inspection, and conventional mechanical testing of coupons machined from the panel. Author

N91-25057*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
EFFECTS OF SOLAR RADIATION ON GLASS Abstract Only **c27**
Dennis S. Tucker and Donald L. Kinser (Vanderbilt Univ., Nashville, TN.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 90 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The effects of solar radiation of selected glasses are reported. Optical property degradation is studied using UV-Vis spectrophotometry. Strength changes are measured using a concentric ring bend test. Direct fracture toughness measurements using an indentation test are planned. Author

N91-25058*# Thiokol Corp., Brigham City, UT.
SPACE AGING OF SOLID ROCKET MATERIALS Abstract Only **c28**
Dean M. Lester, Leon L. Jones, R. B. Smalley, Jr., and R. Neil Ord *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 92 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 21I

Solid rocket propellant and rocket motor components were aged in a vented container on the interior of the LDEF. The results of aging IPSM-II/PAM-DII space motor components are presented. Ballistic and mechanical properties of the space aged main propellant, igniter propellant, and ignition system were compared with similar data from preflight and ground aged samples. Mechanical properties of the composite materials and bonded joints used in the motor case, insulation, liner, nozzle, exit cone, and skirt were similarly evaluated. The space aging results are compared to data collected in a ground based vacuum aging program on similar components. Author

N91-25059*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AN OVERVIEW OF THE FIRST RESULTS ON THE SOLAR ARRAY PASSIVE LDEF EXPERIMENT (SAMPLE), AO171 Abstract Only **c44**
Ann F. Whitaker and Leighton E. Young *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 93 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

Space environmental effects were visibly obvious on

components of experiment AO171 which contained solar cells, composites, polymeric thin films, solar reflectors, protective coatings, metals, paints , and elastomers. Micrometeoroid/space debris impacts were observed on all experiment elements. Luminescence of polyimide, silicone, and polyurethane materials occurred under black light examination. Outgassing of RTV511 occurred mainly as a result of insufficient thermal vacuum bakeout. Solar cell degradation was predominantly below 10 percent. Elastomers lost mass and discolored; composites showed evidence of atomic oxygen attack, and unprotected thin polymer films eroded away. Author

N91-25060*# Air Force Aero Propulsion Lab., Wright-Patterson AFB, OH. Aerospace Power Div.
EXPERIMENT M0003-4: ADVANCED SOLAR CELL AND COVERGLASS ANALYSIS, AN OVERVIEW Abstract Only c44
Terry M. Trumble *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 94 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

The experiment consists of 51 coverglass samples and 12 solar cell strings. Sixteen of the coverglass samples were on the leading edge and 16 on the trailing edge. An additional 16 samples were used as control samples and were not flown. The scenario for analysis was established for the coverglass. A photographic and Namarski survey were taken. Selected sites were then analyzed using surface analysis techniques. The coverglass samples are analyzed in their dirty condition for optical transmission, reflectance, and absorbance. The solar cells were visually inspected and photographed. Tape recorder data is analyzed and selected cell strings are evaluated for their electrical properties. Author

N91-25061*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED PHOTOVOLTAIC EXPERIMENT, S0014: PRELIMINARY FLIGHT RESULTS AND POST-FLIGHT FINDINGS Abstract Only c44
David J. Brinker, John R. Hickey (Eppley Lab., Inc., Newport, RI.), and Donald K. Brasted *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 95 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

The Advanced Photovoltaic Experiment (APEX) is an LDEF experiment designed to provide reference solar cell standards for laboratory measurements as well as to investigate the solar spectrum and the effects of long term exposure of solar cells to the LEO environment. Silicon and gallium arsenide solar cells were flown with the appropriate instrumentation to periodically measure cell performance and temperature. The experimental objectives, the design employed to realize these objectives and the solar cells and instrumentation selected for the flight are presented. A discussion of the flight data returned are included. Preliminary results from the post flight analysis of the absolute cavity radiometer, the digital solar angle sensor, and the Barr Associates narrow bandpass optical filters are also presented. The initial findings of work to determine the chemical nature of contamination layers on APEX are also presented. Author

N91-25062*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DURABILITY EVALUATION OF PHOTOVOLTAIC BLANKET MATERIALS EXPOSED ON LDEF TRAY S1003 Abstract Only c44
Sharon K. Rutledge and Raymond M. Olle (Cleveland State Univ., OH.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 96 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

Several candidate protective coatings on Kapton and uncoated Kapton were exposed to the LEO environment on the LDEF in order to determine whether the coatings could be used to protect polymeric substrates from degradation in the LEO environment. These materials are used for flexible solar array panels in which the polymer is the structural member that supports the solar cell and current carriers. Arrays such as these are used on the Hubble Space Telescope and will be used on Space Station Freedom. The results of the experiments are presented. Author

N91-25063*# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Space Communications and Propulsion Div.
LONG DURATION EXPOSURE FACILITY (LDEF) RESULTS Abstract Only c44
Ludwig Preuss *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 97 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

Thermal control coatings, solar cells, and micrometeoroid capture cells were flown on the LDEF-Experiment S1002 to investigate the behavior of these components under space conditions and to collect micrometeoroids and debris. The experiment and the components to be investigated are described. The visual inspections, electrical and thermooptical measurements as well as chemical and metallurgical investigations conducted on the complete experiment as well as on single components are described, analyzed and discussed. Author

N91-25064*# TRW, Inc., Redondo Beach, CA. Space and Technology Group.
LDEF SP-HVDE (SPACE PLASMA-HIGH VOLTAGE DRAINAGE EXPERIMENT) POST-FLIGHT DATA ON SPACECRAFT LEAKAGE CURRENT AND DISCHARGE Abstract Only c33
J. Y. Yaung, W. C. Wong, B. K. Blakkolb, and L. E. Ryan *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 98 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 09C

Two identical SP-HVDE (Space Plasma-High Voltage Drainage Experiment) trays were designed and fabricated and were flown in the NASA LDEF in the LEO environment. The trays were placed with one near the leading edge and one near the trailing edge, and investigation was performed to compare the environmental interactions on the dielectric samples of the two trays. The original objective was successfully achieved by measuring the first in-flight long term average leakage current through 156 coulometers. Less than 5 percent anomalous behavior of the coulometers were found in the post flight analysis. Author

N91-25065*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
LONG DURATION EXPOSURE FACILITY (LDEF) LOW-TEMPERATURE HEAT PIPE EXPERIMENT PACKAGE (HEPP) Abstract Only c34
Roy McIntosh and Patrick J. Brennan (OAO Corp., Greenbelt, MD.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 99 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20D

The flight test results are discussed obtained with the Heat Pipe Experiment Package (HEPP). The HEPP was designed to demonstrate the performance of an ethane constant conductance heat pipe (CCHP) and an ethane heat pipe diode in microgravity. These heat pipes have a nominal operating temperature range of 140 to 250 K. Also, included in the HEPP is a Phase Change Material (PCM) canister which provides temperature stability through melting and freezing of the n-heptane PCM. A comparison of pre-flight, flight, and post-flight thermal performance is also presented. Author

N91-25066*# McDonnell-Douglas Electronics Co., Saint Louis, MO. Laser and Electronic Systems Div.
RESULTS FROM THE CASCADED VARIABLE CONDUCTANCE HEATPIPE EXPERIMENT ON LDEF Abstract Only c34
Michael G. Grote *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 100 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20D

A Variable Conductance Heat Pipe Experiment (CVCHPE) was successfully flown onboard the LDEF and demonstrated temperature control better than +/- 0.3 C during 50 days of on-orbit data collection in a widely varying external environment. The experiment used two series connected, dry reservoir variable conductance heat pipes which require no electrical power for operation. The heat pipes used a central artery design with ammonia working fluid and nitrogen control gas. Author

N91-25067*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
LONG DURATION EXPOSURE FACILITY: TRANSVERSE FLAT PLATE HEAT PIPE Abstract Only c34
David Shular *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 101 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20D

The Transverse Flat Plate Heat Pipe is a thermal control device that serves the dual function of temperature control and mounting base for electronic equipment. In it's ultimate application, the heat pipe would be a lightweight structural member that could be configured in a platform or enclosure, and provide temperature control for large space structures, flight experiments, and equipment. The purpose of this experiment is to evaluate the zero-G performance of several heat pipe modules. Performance assessment includes: (1) the systems heat transport capability; (2) temperature drop between evaporator and condensor; and (3) the ability to maintain temperature over varying duty cycles and environments. Author

N91-25068*# McDonnell-Douglas Electronics Co., Saint Louis, MO.
POST-FLIGHT CHARACTERIZATION OF OPTICAL SYSTEM SAMPLES, THERMAL CONTROL SAMPLES, AND DETECTORS FROM LDEF EXPERIMENT M0003, SUB-EXPERIMENTS 6 AND 13 Abstract Only c27
Randall R. Hodgson, James N. Holsen, and Robert A. Drerup, Jr. (Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 102 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Flight samples and control samples of optical and thermal control coatings were measured for hemispheric reflectance and transmission. The samples were exposed directly to the orbital environment, but were on the trailing edge of the LDEF satellite. Preliminary analysis shows no significant change in the reflectance of transmission values of most of the samples. Post-flight tests of avalanche photodiodes is also discussed. Author

N91-25069*# Georgia Tech Research Inst., Atlanta.
LDEF ACTIVE OPTICAL SYSTEM COMPONENTS EXPERIMENT Abstract Only c74
M. D. Blue *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 103 (For primary document see N91-24972 16-99)
(Contract NAS1-14654)
Avail: NTIS HC/MF A07 CSCL 20F

A preliminary report on the Active Optical System Components Experiment is presented. This experiment contained 136 components in a six-inch deep tray including lasers, infrared detectors and arrays, ultraviolet light detectors, light-emitting diodes, a light modulator, flash lamps, optical filters, glasses, and samples of surface finishes. The experimental results for those component characteristics appear as much related to the passage of time as to the effects of the space environment, but organic materials and extreme-infrared reflectivity of black paints show unexpected changes. Author

N91-25070*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF LONG-DURATION EXPOSURE ON OPTICAL SYSTEM COMPONENTS Abstract Only c27
Gale A. Harvey *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 104 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The optical materials and UV detectors experiment (SOO50-1) was a set of 18 optical windows, filters, and ultraviolet detectors. The optical specimens were all retrieved in excellent condition. No delamination or blistering of the filters occurred. No discoloration of the optical window materials occurred, but the MgF2 window did experience roughing. The most notable degradation of the optics were the deposition of an organic film on the exposed surfaces. The film absorption was measured using a Fourier transform infrared spectrometer and a UV spectrometer. The 6 percent absorption at 3.4 microns corresponds to about 100 mgm/sq ft of organic film. The UV absorption was almost 100 percent at 200 nm and about 50 percent at 380 nm. Author

N91-25071*# Eastman Kodak Co., Rochester, NY.
EFFECTS OF LONG TERM EXPOSURE ON OPTICAL SUBSTRATES AND COATINGS (SOO50-1) Abstract Only c27
John Vallimont and Keith Havey *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 105 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The experiment consisted of fused silica and ultra low expansion (ULE(tm)) glass samples which were either uncoated or had high reflectance silver, antireflectance, or solar rejection coatings. A set of duplicate control samples was manufactured and stored in a controlled environment for comparison purposes. Data on the analysis of the contaminate deposited on the samples, micrometeoroid impact, and the environmental effects on the substrate materials and coatings are presented. Some results of particular interest are that the contaminate composition varied between different types of samples, fractures were incurred in the glass at the micrometeoroid impact site, and no darkening of the ULE(tm) glass occurred due to the radiation exposure. Author

N91-25072*# Optical Coating Lab., Inc., Santa Rosa, CA.
OPTICAL PERFORMANCE OF EXPOSED SOLAR CELL COVERS Abstract Only c44
Bryant P. Hichwa, Steven R. Selee, Jerry Dodds, and Greg S. Long *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 106 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10A

The characterization results of samples flown on the Long Duration Exposure Facility (LDEF) are discussed. These samples included both coated and uncoated fused silica and ceria glass substrates used in the manufacture of solar cell covers. The coatings comprised a single-layer magnesium fluoride antireflection coating and an all-dielectric high-reflector multilayer coating centered at 350 nm. Samples were mounted on both the leading and trailing surfaces of the LDEF for exposure to the environment of space. The optical properties of the coatings will be compared to control samples which were stored on the ground during the LDEF Mission. Results of Auger Electron Spectroscopy and Rutherford Backscatter Spectroscopy measurements made on several of the coatings are presented to explain the effects of space on the chemical composition of the coatings. Author

N91-25073*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECT OF SPACE EXPOSURE ON PYROELECTRIC INFRARED DETECTORS Abstract Only c27
James B. Robertson and Ivan O. Clark *In its* First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 107 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Twenty pyroelectric type infrared detectors were flown onboard the Long Duration Exposure Facility (LDEF). The detector chips were of three different pyroelectric materials: lithium-tantalate, strontium-barium-niobate, and triglycine-sulfide. The experiment was passive; no measurements were taken during the flight.

Performance of the detectors was measured before and after flight. Postflight measurements revealed that detectors made of lithium-tantalate and strontium-barium-niobate suffered no measureable loss in performance. Detectors made of triglycine-sulfide suffered complete loss of performance, but so did the control samples of the same material. Repoling of the triglycine-sulfide failed to revive the detectors. Author

N91-25074*# MATRA Service Aerodynamique, Velizy-Villacoublay (France).
VACUUM DEPOSITED OPTICAL COATINGS EXPERIMENT (AO 138-4) Abstract Only **c27**
Jean Charlier *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 108 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The aim of this experiment was to test the optical behavior of 20 components and coatings subjected to space exposure. Most of them are commonly used for their reflective or transmittive properties in spaceborne optics. They consist in several kind of metallic and dielectric mirrors designed for the 0.12 to 10 microns spectrum, UV, and NIR bandpass filters, visible, and IR antireflecting coatings, visible/IR dichroic beam splitters, and visible beam splitter. The coatings were deposited on various substrates such as glasses, germanium, magnesium fluoride, quartz, zinc selenide, and kanigened aluminum. Several coating materials were used such as Al, Ag, Au, MgF2, LaF3, ThF3, ThF4, SiO2, TiO2, ZrO2, Al2O3, MgO, Ge, and ZnSe. Five samples of each component were manufactured. Two flight samples were mounted in such a way that one was directly exposed to space and the other looking backwards. The same arrangement was used for the spare samples stored on ground in a box identical to the flight one and they were kept under vacuum during the LDEF mission. Finally, one set of reference components was stocked in a sealed box under a dry nitrogen atmosphere. By comparing the preflight and postflight optical performances of the five samples of each component, it is possible to detect the degradations due to the space exposure. Author

N91-25075*# Instruments Service Aerodynamique, Longjumeau (France). Grating Dept.
RULED AND HOLOGRAPHIC GRATINGS EXPERIMENT (AO 138-5) Abstract Only **c35**
Francis Bonnemason *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 109 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20E

Experiments on the the Long Duration Exposure Facility involving the study of the behavior of diffraction gratings, ruled replica, holographic, and ion etched masters with a long exposure to the space environment are discussed. To separate the metallic coatings compartment, some mirrors were added to the experiment. In order to be free from grating senescence on ground, one set of reference compounds was stored. Two sets of compounds were loaded, exposed, and shaded typed, in order to differentiate vacuum influences and sun illumination, cosmic dust, and radiation incidences. The investigation of possible damages was operated according to the fundamental triple point of view of wavefront flatness, absolute efficiency, and stray light level. Author

N91-25076*# Reading Univ. (England). Infrared Multilayer Lab.
EXPOSURE TO SPACE RADIATION OF HIGH-PERFORMANCE INFRARED MULTILAYER FILTERS Abstract Only **c27**
J. S. Seeley, G. J. Hawkins, and R. Hunneman *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 110 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

The University of Reading experiment exposed IR interference filters and crystal substrates on identical earth facing and leading-edge sites of the Long Duration Exposure Facility (LDEF). Filters mostly comprised multilayer coatings of lead telluride (PbTe)/II-IV on germanium (Ge) and other substrates: crystals comprised CdTe, MgF2, sapphire, quartz, silicon, and some softer materials. Identical control samples were maintained in the laboratory throughout the experiment. The filters were novel in their design, construction and manufacture, and categorized high-performance because of their ability to resolve emission spectra of the important atmospheric gases for various purposes in remote sensing. No significant changes were found in the spectra of the hard-coated filters or in the harder crystals (the softer materials were degraded to an extent). By virtue of this well-documented and long exposure in LDEF, the qualification of the filter type is significantly improved for its future requirements. Author

N91-25077*# Eppley Lab., Inc., Newport, RI.
PASSIVE EXPOSURE OF EARTH RADIATION BUDGET EXPERIMENT COMPONENTS LDEF EXPERIMENT AO-147: POST-FLIGHT EXAMINATIONS AND TESTS Abstract Only **c46**
John R. Hickey *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 111 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 04A

The Passive Exposure of Earth Radiation Budget Experiment Components (PEERBEC) experiment of the Long Duration Exposure Facility (LDEF) mission was composed of sensors and components associated with the measurement of the earth radiation budget (ERB) from satellites. These components included the flight spare sensors from the ERB experiment which operated on Nimbus 6 and 7 satellites. The experiment components and materials as well as the pertinent background and ancillary information necessary for the understanding of the intended mission and the results are described. The extent and timing of the LDEF mission brought the exposure from solar minimum between cycles 21 and 22 through the solar maximum of cycle 22. The orbital decay, coupled with the events of solar maximum, caused the LDEF to be exposed to a broader range of space environmental effects than were anticipated. The mission spanned almost six years concurrent with the 12 year (to date) Nimbus 7 operations. Preliminary information is presented on the following: (1) the changes in transmittance experienced by the interference filters; (2) the results of retesting of the thermopile sensors, which appear to be relatively unaffected by the exposure; and (3) the results of the recalibration of the APEX cavity radiometer. The degradation and recovery of the filters of the Nimbus 7 ERB are also discussed relative to the apparent atomic oxygen cleaning which also applies to the LDEF. Author

N91-25078*# Barr Associates, Inc., Westford, MA.
TRANSMITTANCE MEASUREMENTS OF ULTRA VIOLET AND VISIBLE WAVELENGTH INTERFERENCE FILTERS FLOWN ABOARD LDEF Abstract Only **c27**
Thomas A. Mooney and Ali Smajkiewicz *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 112 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

A set of ten interference filters for the UV and VIS spectral region were flown on the surface of the Long Duration Exposure Facility (LDEF) Tray B-8 along with earth radiation budget (ERB) components from the Eppley Laboratory. Transmittance changes and other degradation observed after the return of the filters to Barr are reported. Substrates, coatings, and (where applicable) cement materials are identified. In general, all filters except those containing lead compounds survived well. Metal dielectric filters for the UV developed large numbers of pinholes which caused an increase in transmittance. Band shapes and spectral positioning, however, did not change. Author

N91-25079*# Naval Weapons Center, China Lake, CA.
SPACE ENVIRONMENTAL EFFECTS ON COATED OPTICS Abstract Only **c74**
T. M. Donovan, J. M. Bennett, and S. R. Gyetvay (Aerospace Corp., Los Angeles, CA.) *In* NASA, Langley Research Center,

First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 113 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20F

Several multilayer coated mirror designs developed for potential space applications were tested on the Long Duration Exposure Facility (LDEF) along with single layer witness coatings deposited on fused silica and a coated CaF2 window. Performance requirements included high mirror reflectivity, low absorption, low scatter, environmental durability, and radiation hardness. The designs were selected in screening tests using combined electron, proton, and simulated solar UV radiation. The purpose of the space test was to validate the above test results and determine the effects of atomic oxygen and contamination on mirror performance. Author

N91-25080*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
LDEF FIBER OPTIC EXPOSURE EXPERIMENT Abstract Only **c74**

Alan R. Johnston, Larry A. Bergman, and Ron Hartmayer *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 114 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20F

Ten fiber optic cable samples of different types were exposed in low Earth orbit for over 5.5 years on the Long Duration Exposure Facility (LDEF). Four of the samples were mounted externally, and the remaining six were internal, under approximately .5 gc/sq m of aluminum. The experiment was recovered in January of 1990, and laboratory evaluation of the effects of the exposure has continued since. An increase in loss, presumed to be from radiation darkening, aging effects on polymer materials used in cabling, unique contamination effects on connector terminations, and micrometeoroid impacts were observed on some of the samples. In addition, the dependence of sample loss was measured as a function of temperature before and after the flight. All cable samples were functional, and the best exhibited no measurable change in performance, indicating that conventional fiber optic cables can perform satisfactorily in spacecraft. Experimental results obtained to date will be presented and discussed. Author

N91-25081*# Air Force Systems Command, Kirtland AFB, NM. Optoelectronics Section.
PRELIMINARY ANALYSIS OF WL EXPERIMENT NUMBER 701: SPACE ENVIRONMENT EFFECTS ON OPERATING FIBER OPTIC SYSTEMS Abstract Only **c74**

E. W. Taylor, R. J. Padden, J. N. Berry, A. D. Sanchez, and S. P. Chapman *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 115 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20F

A brief overview of the analysis performed on WL Experiment number 701 is presented, highlighting the successful operation of the first know active fiber optic links orbited in space. Four operating fiber optic links were exposed to the space environment for a period exceeding five years, situated aboard and external to the Long Duration Exposure Facility (LDEF). Despite the prolonged space exposure to radiation, wide temperature extremums, atomic oxygen interactions, and micrometeorite and debris impacts, the optical data links performed well within specification limits. Early Phillips Laboratory tests and analyses performed on the experiment and its recovered magnetic tape data strongly indicate that fiber optic application in space will have a high success rate. Author

N91-25082*# Martin Marietta Labs., Baltimore, MD.
STUDY OF FACTORS DETERMINING THE RADIATION SENSITIVITY OF QUARTZ CRYSTAL OSCILLATORS (AO189) Abstract Only **c27**

J. S. Ahearn and J. D. Venables *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 116 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 11C

Quartz resonators fabricated from two different grades of quartz material and selected for their susceptibility to radiation damage as determined by transmission electron microscopy (TEM), were tested prior to the LDEF flight. These resonators were then flown on the LDEF mission where they were exposed to the radiation environment of low Earth orbit. Post-flight tests were then conducted to determine any differences in resonator performance caused by the space exposure. Results of the TEM analysis of the quartz material and preflight and postflight measurements of the flight resonators and of the space and ground based control resonators are presented. Further planned work on the TEM analysis of the quartz materials will also be outlined. Author

N91-25083*# Grumman Aerospace Corp., Bethpage, NY.
EFFECTS OF SPACE ENVIRONMENT ON SPACE-BASED RADAR PHASED-ARRAY ANTENNA: STATUS AND PRELIMINARY OBSERVATIONS Abstract Only **c32**

J. B. Whiteside, D. Giangano, R. L. Heuer, E. Kamykowski, M. Kesselman, W. Rooney, R. Schulte, and Michael C. Stauber *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 117 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20N

The overall objective is to evaluate the effect of the space environment on Kapton films considered for the Grumman space based radar (SBR) phased-array antenna. The most striking result is the overall good condition of the Kapton antenna planes and Kapton tensile specimens. This is largely attributable to the orientation of the Kapton (parallel and flush on the space end) and the stability of the LDEF in orbit. Results on elongation and mechanical properties of the plain and fiberglass reinforced Kapton will be described. Stress-dependent permanent deformation and some reductions in strain to failure were observed. Physical property testing of the materials is in progress. Electronic data acquisition and memory systems appeared to operate correctly, but functional tests were not yet performed. An evaluation of the high voltage-plasma interaction data is underway. Some minor systems anomalies (e.g., fastener sheared during removal, strong odor inside electronics container) were noted. Other observations such as radiation, contamination, impacts, and orientation features of atomic oxygen erosion are reported. Author

N91-25084*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SYSTEMS SPECIAL INVESTIGATION GROUP OVERVIEW Abstract Only **c33**

James B. Mason, Harry Dursch, and Joel Edelman (Long Duration Exposure Facility Newsletter, Silver Spring, MD.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 118 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 09C

The Systems Special Investigation Group (SIG) has undertaken investigations in the four major engineering disciplines represented in the Long Duration Exposure Facility (LDEF) hardware: electrical, mechanical, thermal, and optical systems. Testing was planned for the highest possible level of assembly, and top level system tests for nearly all systems were performed at this time. To date, testing was performed on a mix of LDEF and individual experimenter systems. No electrical or mechanical system level failures attributed to the spaceflight environment have yet been detected. Some low cost electrical components were used successfully, although relays were a continuing problem. Mechanical galling was observed unexpectedly, but no evidence of cold welding was identified yet. A working index of observed systems anomalies was created and will be used to support the tracking and resolution of these effects. The LDEF hardware currently available to the Systems SIG includes most of the LDEF systems hardware, and some significant experimenter hardware as well. A series of work packages was developed for each of several subsystem types where further testing is of critical interest. The System SIG is distributing a regular newsletter to the greater LDEF community in order to maintain coherence in an investigation which is widely scattered both in

subject matter and in geography. Circulation of this informal document has quadrupled in its first year. Author

N91-25085*# Boeing Aerospace and Electronics Co., Seattle, WA.
LDEF ELECTRONIC SYSTEMS: SUCCESSES, FAILURES, AND LESSONS Abstract Only **c33**
Emmett Miller, Dave Porter, Dave Smith, Larry Brooks, Joe Levorsen, and Owen Mulkey *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 119 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 09C

Following the Long Duration Exposure Facility (LDEF) retrieval, the Systems Special Investigation Group (SIG) participated in an extensive series of tests of various electronic systems, including the NASA provided data and initiate systems, and some experiment systems. Overall, these were found to have performed remarkably well, even though most were designed and tested under limited budgets and used at least some nonspace qualified components. However, several anomalies were observed, including a few which resulted in some loss of data. The postflight test program objectives, observations, and lessons learned from these examinations are discussed. All analyses are not yet complete, but observations to date will be summarized, including the Boeing experiment component studies and failure analysis results related to the Interstellar Gas Experiment. Based upon these observations, suggestions for avoiding similar problems on future programs are presented. Author

N91-25086*# Boeing Aerospace and Electronics Co., Seattle, WA.
LDEF MECHANICAL SYSTEMS Abstract Only **c37**
Steve Spear and Harry Dursch *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 120 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 13I

Following the Long Duration Exposure Facility (LDEF), the Systems Special Investigation Group (SIG) was involved in a considerable amount of testing of mechanical hardware flown on the LDEF. The primary objectives were to determine the effects of the long term exposure on: (1) mechanisms employed both on the LDEF or as part of individual experiments; (2) structural components; and (3) fasteners. Results of testing the following LDEF hardware are presented: LDEF structure, fasteners, trunnions, end support beam, environment exposure control cannisters, motors, and lubricants. A limited discussion of PI test results is included. The lessons learned are discussed along with the future activities of the System SIG. Author

N91-25087*# Boeing Aerospace and Electronics Co., Seattle, WA.
ON-ORBIT COLDWELDING Abstract Only **c37**
Harry Dursch and Steve Spear *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 121 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 13I

Spacecraft mechanisms are required to operate in the space environment for extended periods of time. A significant concern to the spacecraft designer is the possibility of metal to metal coldwelding or significant increases in friction. Coldwelding can occur between atomically clean metal surfaces when carefully prepared in a vacuum chamber on earth. The question is whether coldwelding occurs in orbit service conditions. The results of the System Special Investigation Group's (SIG's) investigation into whether coldwelding had occurred on any Long Duration Exposure Facility (LDEF) hardware are presented. The results of a literature search into previous ground based anomalies is also presented. Results show that even though there have been no documented on-orbit coldwelding related failures, precautions should be taken to ensure that coldwelding does not occur in the space environment and that seizure does not occur in the prelaunch or launch environment. Author

N91-25088*# AZ Technology, Huntsville, AL.
THERMAL CONTROL SURFACES EXPERIMENT (SOO69) FLIGHT SYSTEMS PERFORMANCE Abstract Only **c18**
Donald R. Wilkes and Leigh L. Hummer *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 122 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

The thermal control surfaces experiment (TCSE) was the most complex hardware system aboard the Long Duration Exposure Facility (LDEF). The TCSE system consists of a scanning spectroreflectometer that measured test samples mounted on a rotatable carousel assembly. A microprocessor based data system controlled all aspects of TCSE system operation. Power was provided by four primary batteries. Flight measurement and housekeeping data were stored on a tape recorder for postflight analysis. The TCSE is a microcosm of complex electro-optical payloads being developed by NASA, DoD, and the aerospace community. The TCSE provides valuable data on the performance of these systems in space. The TCSE flight system and its excellent performance on the LDEF mission are described. A few operational anomalies were encountered and are discussed. Initial post-flight tests show that the TCSE system remains functional although some degradation in the optical measurements were observed. The results of these tests are also presented. Author

N91-25089*# Centre National d'Etudes Spatiales, Toulouse (France).
POST FLIGHT SYSTEM ANALYSIS OF FRECOPA (AO 138) Abstract Only **c31**
Christian Durin *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 123 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 13B

The unexpected duration for the flight of the Long Duration Exposure Facility (LDEF) conducted CNES to create a special investigation group in order to analyze all the materials and systems which compose the French Cooperative Payload (FRECOPA) except the experiments especially prepared for the flight. The FRECOPA tray was on the trailing face (V-) of the LDEF and protected from the atomic oxygen flux during all the flight. However, the solar irradiation was very important with solar flux quite perpendicular to the experiment once an orbit. There was also a good vacuum environment. The objectives are to test the effects of the combined space environment on materials and components like: structure, thermal control coatings and blankets, electronic unit, motors, and mechanical fixtures. When the LDEF returned to Kennedy Space Center, a visual inspection showed the very good behavior of the materials used and it was noted that the three mechanisms to open and close the experiment canisters worked completely. Many impacts of micrometeoroids or space debris on the structure and on the thermal protections were observed. After FRECOPA was brought back to Toulouse, many tests were performed and include: working order tests, mechanical tests (tension), optical and electronic microscopy (SEM), surface analysis (ESCA, SIMS, RBS, AUGER, etc.), thermal analysis, pressure measurements, and gas analysis (outgassing tests). The results of these experiments are discussed. Author

N91-25090*# Aerospatiale, Cannes (France).
EFFECTS OF ULTRAVACUUM AND SPACE ENVIRONMENT ON CONTACT OHMIC RESISTANCE (AO 138-11) Abstract Only **c33**
Jean Pierre Assie and Alfred Perotto *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 124 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 09C

The experiment was aimed at checking compatibility of the aluminum conductors with conventional conductors and contacts under different conditions of manufacturing (mechanical or magnetostrictive crimping) and storage in laboratory or in long-duration space environment. The electrical characteristics of connections built from nickel-plated conductors and glided copper

contacts were noted to vary over the duration of the experiment. These variations are unrelated with the crimping or storage conditions or with metal pairing (nickel-plated aluminum/tinned or silver copper). Such evolutions, even slight, are detrimental to connection quality. The same observations hold for some like connections subjected to long-duration thermal cycles. Therefore, work on aluminum technology was reoriented toward a silver aluminum conductor/ golded aluminum contact solution. The first evaluation test performed according to this definition have yielded satisfactory results. Author

N91-25091*# Aerospatiale, Cannes (France).
MICROWELDING OF VARIOUS METALLIC MATERIALS UNDER ULTRAVACUUM (AO 138-10) Abstract Only c37
Jean Pierre Assie and Eric Conde (Centre National d'Etudes Spatiales, Toulouse, France) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 125 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 13I

The first finding from the AO 138-10 is that cold welding never occurred, and that microwelds didn't even affect the reference (presumably microweld prone) pairs of metals consisting of gold, silver, and chromium. The scientific disappointment from these results must be tempered by the notion of a static AO 138-10 experiment, reflecting the passive character of the global Long Duration Exposure Facility (LDEF) flight. Thus far, it has been theorized that cold welding results from the peeling of the oxide layer, that is formed in an earth environment, by the space environment since such a layer no longer grows in space. In fact, such stripping of the oxide layer supposes relative motion of the contacting materials. In the absence of such motion, as in this experiment, oxidation will preserve its integrity and continue to prevent microwelding. More bewildering is that there was no microwelding of the reference pairs. Even though AO 138-10 failed scientific expectations, as did the LDEF structure with cold welding, the positive, functional aspect to keep in mind is the safe operation of single-shot (appendage releasing and/or latching) mechanisms, unhindered by microwelding in a space vacuum, as now demonstrated by the statically representative pairs of materials. Other aspects of the experiment are discussed. Author

N91-25092*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
LONG DURATION EXPOSURE FACILITY (LDEF) LOW-TEMPERATURE HEAT PIPE EXPERIMENT PACKAGE (HEPP) POWER SYSTEM RESULTS Abstract Only c44
Smith E. Tiller and David Sullivan *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 126 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 10B

An overview of a self contained Direct Energy Transfer (DET) Power System which was developed to provide power to the Long Duration Exposure Facility (LDEF) Heat Pipe Experiment Package (HEPP) Experiment. A brief synopsis of the flight characteristics of the power system are presented to illustrate the system's capability to function successfully in a low Earth orbit (LEO) space environment. The successful space flight operations of the battery, solar arrays, and power system electronics during the flight period of almost six years (approximately 32,000 LEO cycles) are discussed. Author

N91-25093*# Technical Univ. of Denmark, Lyngby. Physics Lab.
RESULTS OF THE TTF-TCNQ- AND THE CALCIUM CARBONATE-CRYSTALLIZATION ON THE LONG DURATION EXPOSURE FACILITY Abstract Only c76
Kjeld Flemming Nielsen and M. David Lind (Rockwell International Science Center, Thousand Oaks, CA.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 128 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 20L

Experiment AO139A on the Long Duration Exposure Facility (LDEF) carried four large containers into orbit for five years with crystal growth solutions for lead sulfide, calcium carbonate, and tetra thiafulvalene- tetra cyanoquino methane (TTF-TCNQ). The LDEF was in excellent condition after the long orbital stay, and although the temperature data was lost, the experiment program had been working since the valves in all containers were opened. All four experiments produced crystals; however, they were of varying quality. The calcium carbonate crystals had the best appearance. The TTF-TCNQ crystals were packed together near the valve openings of the container. When taken apart, the single crystals showed some unusual morphological properties. X-ray investigations as well as conductivity measurements on the long duration space grown TTF-TCNQ crystals are presented, and pictures of the calcium carbonate are shown. Comparisons are made with previous space solution growth experiments on the European Spacelab Mission and the Apollo-Soyuz Test Project. Author

N91-25094*# Park (George W.) Seed Co., Inc., Greenwood, SC.
SEEDS IN SPACE EXPERIMENT RESULTS Abstract Only c51
Jim A. Alston *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 129 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 06C

Two million seeds of 120 different varieties representing 106 species, 97 genera, and 55 plant families were flown aboard the Long Duration Exposure Facility (LDEF). The seeds were housed on the space exposed experiment developed for students (SEEDS) tray in sealed canister number six and in two small vented canisters. The tray was in the F-2 position. The seeds were germinated and the germination rates and development of the resulting plants compared to the control seed that stayed in Park Seed's seed storage facility. The initial results are presented. There was a better survival rate in the sealed canister in space than in the storage facility at Park Seed. At least some of the seeds in each of the vented canisters survived the exposure to vacuum for almost six years. The number of observed apparent mutations was very low. Author

N91-25095*# Oklahoma State Univ., Stillwater.
SPACE EXPOSED EXPERIMENT DEVELOPED FOR STUDENTS (SEEDS) P-0004-2 Abstract Only c51
Doris K. Grigsby *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 130 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 06C

This cooperative endeavor of NASA Headquarters, the NASA Langley Research Center, and the George W. Park Seed Company, resulted in the distribution, by the end of March, 1990, of approximately 132,000 space exposed experiment developed for students (SEEDS) kits to 64,000 teachers representing 40,000 classrooms and 3.3 million kindergarden through university students. Kits were sent to every state, as well as to 30 foreign countries. Preliminary radiation data indicates that layer A received 725 rads, while layer D received 350 rads. Germination rate was reported to be 73.8 percent for space exposed seeds and 70.3 percent for earth based control seeds. Tests conducted within the first six months after retrieval indicated space exposed seeds germinated in an average of 8.0 days, while earth based control seeds' average germination rate was 8.3 days. Some mutations (assumed to be radiation induced) reported by students and Park Seed include plants that added a leaf instead of the usual flower at the end of the flower front and fruit produced from a flower with a variegated calyx bore seeds producing albino plants, while fruit from a flower with a green calyx from the same plant bore seeds produced green plants. Author

N91-25096*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Biophysics Div.
FIRST BIOLOGICAL AND DOSIMETRIC RESULTS OF THE FREE FLYER BIOSTACK EXPERIMENT AO015 ON LDEF Abstract Only c51

G. Reitz, H. Buecker, R. Facius, G. Horneck, M. Schaeffer, J. U. Schott, J. Bayonove, R. Beaujean, E. V. Benton, and M. Delpoux (Toulouse Univ., France) et al *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 131 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 06C

The main objectives of the Biostack Experiment are to study the effectiveness of the structured components of the cosmic radiation to bacterial spores, plant seeds, and animal cysts for a long duration spaceflight and to get dosimetric data such as particle fluences and spectra and total doses for the Long Duration Exposure Facility orbit. The configuration of the experiment packages allows the localization of the trajectory of the particles in each biological layer and to correlate the potential biological impairment or injury with the physical characteristics of the responsible particle. Although the Biostack Experiment was designed for a long duration flight of only nine months, most of the biological systems show a high hatching or germination rate. Some of the first observations are an increase of the mutation rate of embryonic lethals in the second generation of Arabidopsis seeds, somatic mutations, and a reduction of growth rates of corn plants and a reduction of life span of Artemia salina shrimps. The different passive detector systems are also in a good shape and give access to a proper dosimetric analysis. The results are summarized, and some aspects of future analysis are shown. Author

N91-25097*# American Space Technology, Inc., Santa Monica, CA.
RETRIEVABLE PAYLOAD CARRIER (RPC): NEXT GENERATION LONG DURATION EXPOSURE FACILITY
Abstract Only **c18**
Arthur T. Perry *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 132 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

The Retrievable Payload Carrier (RPC) is described which is a multi-experiment, free-flyer spacecraft being privately developed to make in-space experimentation more accessible and economically feasible for research and development organizations. The carrier concept was derived from NASA's highly successful and flight proven Long Duration Exposure Facility (LDEF). The LDEF capabilities were enhanced to meet new customer requirements. This reusable payload carrier is planned for launch and retrieval by the space shuttle on a regular basis. The RPC's compact design facilitates flexible manifesting of the shuttle cargo bay space, thereby, permitting timely launches and retrievals. The vehicle is designed so that either the entire carrier can be retrieved from orbit, or individual experiment pallets can be removed and replaced in orbit. This gives customers even greater control over their experiment recoveries. A fully operational RPC System consists of: (1) a carrier spacecraft; (2) a ground control station for communication with customer payloads and the carrier; (3) a ground processing facility to provide refurbishment, final checkout, and integration of customer payloads and the carrier; and (4) the personnel required to support both the development and operation phases of the program. Customer payloads will fly 6 to 18 month missions, or longer, as required. Spreading launch, operations, and retrieval costs over multiple experimental payloads results in minimized customer costs. The RPC Program's initial objective is to operate a simple carrier system which meets basic customer service needs. Author

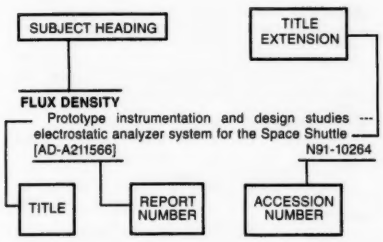
N91-25098*# The Land, Lake Buena Vista, FL.
SURVIVAL OF EPIPHYTIC BACTERIA FROM SEED STORED ON THE LONG DURATION EXPOSURE FACILITY (LDEF)
Abstract Only **c18**
Andrew C. Schuerger, Bret L. Norman, and Joseph A. Angelo, Jr. (Science Applications International Corp., Melbourne, FL.) *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts Jun. 1991 p 133 (For primary document see N91-24972 16-99)
Avail: NTIS HC/MF A07 CSCL 22B

This study was designed to determine the survival of microorganisms exposed to the relatively harsh conditions found in low Earth orbit (LEO). Seed of corn, sunflower, canteloupe, zucchini, bean, pea, and pumpkin cultivars were packaged in two 18 x 2.5 cm aluminum tubes; wall thickness for each tube was 1.33 mm. One seed tube was attacked to payload M0006, tray C-2; a second tube was stored at room temperature in a lab on Earth. Five lithium fluoride thermoluminescent dosimetry wafers (TLD-100 wafers) were placed in each aluminum tube. The total mean dosages for flight and ground-control TLD wafers were 210.0 and 0.9 rads, respectively. Seeds were washed for 2 hrs in a phosphate buffered saline solution. Bacteria were isolated by plating samples of the seed-washings onto dilute tryptic soy agar. Pure isolates of morphologically distinct bacteria were obtained by standard microbiological procedures. Bacteria were grouped according to colony-type and preliminary identification was completed using a fatty-acid analysis system. Bacillus spp. were the primary microoganisms that survived on seed during the experiment. Bacterial diversity and relative abundance were similar for the ground flight seed. Bacillus subtilus, B. pumilus, B. licheniformis, B. polymyxa, B. megaterium, and B. pabuli were isolated most frequently. Members of the genera Kurthia, Listeria, Micrococcus, and Arthrobacter were also isolated from flight and ground control seed. Results support the hypothesis that terrestrial microorganisms can survive long periods of time in the relatively harsh LEO environment. Author

N91-25099*# National Aeronautics and Space Administration, Washington, DC.
RESEARCH AND TECHNOLOGY OBJECTIVES AND PLANS SUMMARY (RTOPS) Research and Technology Program, FY 1989
Jan. 1989 210 p
(NASA-TM-101203; NAS 1.15:101203) Avail: NTIS HC/MF A10 CSCL 05A

This publication represents the NASA research and technology program for FY89. It is a compilation of the Summary portions of each of the RTOPs (Research and Technology Objectives and Plans) used for management review and control of research currently in progress throughout NASA. The RTOP Summary is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities. The first section containing citations and abstracts of the RTOPs is followed by four indexes: Subject, Technical Monitor, Responsible NASA Organization, and RTOP Number. Author

Typical Subject Index Listing



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Ada compiler validation summary report: Certification number: 900228W1.11001, Verdix Corporation, VAda-110-6161, version 6.0.2, DECstation 3100 greater than or equal to DECstation 3100
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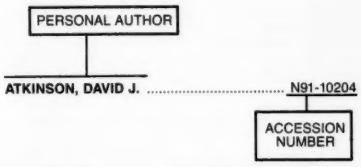

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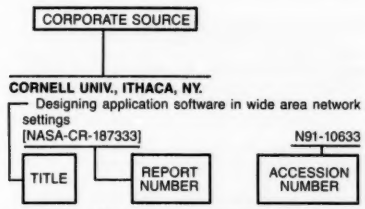

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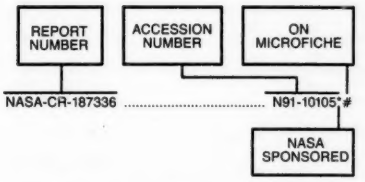

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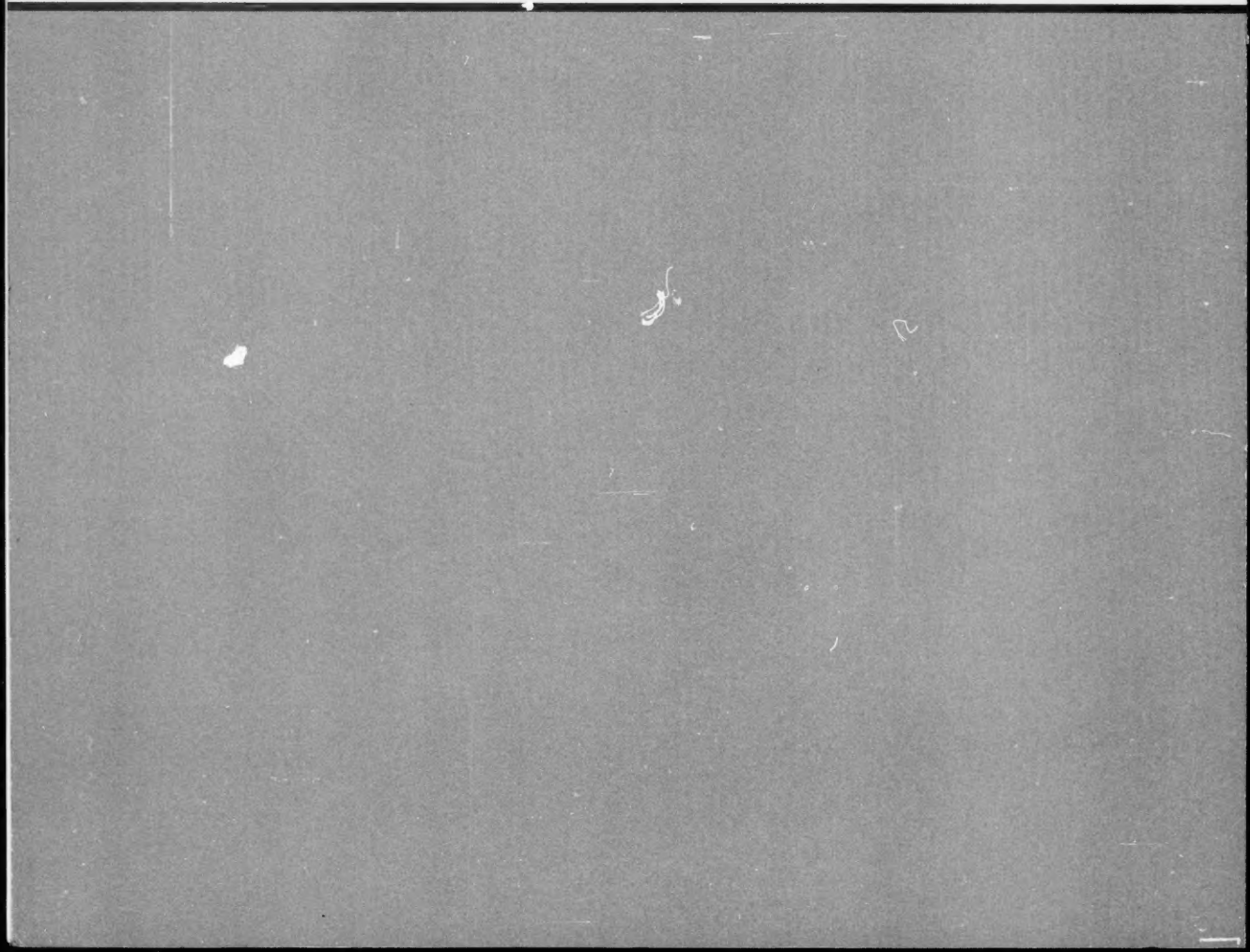
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